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No. 3081

United States Circuit Court of Appeals

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For the Ninth Circuit

MINERALS SEPARATION, LTD., ET AL,

Appellees,

vs.

BUTTE & SUPERIOR MINING COMPANY,

Appellant.

Transcript of Record

Volume 7

(Pages 3541 to 4212, Inclusive)

UPON APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF MONTANA

McKee Ptg. Co., Butte, Mont.

Prof. Arthur Fay Taggart.

these deaths and gets an average expectation of life for a man of a given age, ~~and~~ and on that average enormous sums of money are invested. Now here is a set of data with variations certainly not so great as in the case of the actuary; and while it is impossible for the mind to grasp the whole situation of these detailed figures, and all you can do is to pick exceptions —The general trend of results is convincingly shown by this curve representing the average.

THE COURT: I think I understand what the witness is endeavoring to arrive at now. I will have to get out my old algebra and brush up a little.

MR. SCOTT: Professor, you may mark that diagram on the other side so as to keep it in the record.

Diagram 24 of Professor Taggart, admitted in evidence marked DEFENDANT'S EXHIBIT No. 200.

Q. 14. BY MR. GARRISON: Are all these charts the same?

A. One half of them show the relation of dilution to oil, and the other half show the relation of the amount of sulphide to oil.

Q. 15. But they all proceed on the same principle?

A. Yes, sir.

MR. GARRISON: I don't see why it is necessary to go into the details of those things.

Q. 16. THE COURT: This line which you curve through there, that is done to give the detail of these things, and then you connect them up?

A. That is a chronological curve. Now, I have some of those same data presented chronologically, and there you get that variation; but if you desire, for instance, in this particular chart, the average curve, we proceed in exactly the same way that I proceeded here, and the average curve would come in in some such fashion as this. This would be a much more difficult problem, because the average curve is practically on a straight line, and we would have to fool around a long time to get the particular curve line.

THE COURT: Well, I think it is 5 o'clock. If there is any way you can facilitate the examination by these other gentlemen, you might do it. You expect to put in each one of these with an explanation, I suppose?

MR. SCOTT: That is our intention, yes, sir.

Adjournment until Wednesday, May 2nd, at 10 a. m.

Wednesday, May 2nd, 1917, 10 o'clock a. m.

PROF. TAGGART on the stand.

DIRECT EXAMINATION Resumed
BY MR. SCOTT:

Q. 17. I think you were explaining the first graph when we closed—the first one you mentioned, I mean

P. 3543, L. 12, " the same percentage of water in the feed ; and " after " are "

P. 3543, L. 14, insert " the pounds of oil per ton of feed and that the same variation as before holds, namely," after " namely,"

used, at the Arthur plant of the Utah Copper Company, and I have shown that, as the percentage of dilution of the feed increased—that is, as the percentage of water in the feed increased, other factors remaining approximately constant, that the pounds of oil necessary to get a satisfactory recovery increased also.

Now, I have some other curves. Here, for instance, is a curve of the Utah Copper Company, Magna plant, the curve No. 3 of the Utah Copper Company, Magna plant. You will notice there again that the ordinates, or the values of the vertical scale are the abscissae, or the values of the horizontal scale are the same, namely, that the amount of oil necessary increases as the amount of water in the feed increases.

Again in curve No. 1 of the Utah Copper Company, Magna plant, is shown the same relation between the percentage of water in the feed and the pounds of oil necessary per ton of feed.

Now, at the plant of the Ray Consolidated Copper Company at Hayden, we have exactly the same relation between the percentage of water in the feed and the pounds of oil per ton.

Here is a curve showing the work of the Butte & Superior Mining Company, plotted in exactly the same way; the percentage of water in the feed, as the vertical scale, increasing upward; the pounds of oil per ton of feed, as the horizontal scale, increasing to

from original records of flotation slime vanner tailings plant for periods of ten days for the year 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 203.

MR. SCOTT: I now offer the graph for the Ray Consolidated Copper Company, showing the relation of pounds of oil per ton of feed to the percentage of dilution of feed, the same being based on data from the original records of vanner concentrate flotation plant for ten day periods during the year 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 204.

MR. SCOTT: I now offer graph for the Chino Copper Company, Hurley plant, showing the relation of pounds of oil used per ton of feed to the percentage of water in the feed, the same being based on data taken from the original records of the vanner concentrate plant, month of November, 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 205.

MR. SCOTT: I offer a graph for the Butte & Superior Mining Company, showing the relation of pounds of oil per ton of flotation feed to the percentage of water in the feed, the same being based on data compiled from the original flotation records, for the month of November, 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 206.

Prof. Arthur Fay Taggart.

Q. 20. Have you compiled similar graphs representing the relation of the amount of oil to the amount of sulphides in the feed?

A. I have.

Q. 21. Will you produce them?

A. Now, the first one that I would like to call attention to is that No. 2 of the Utah Copper Company, in which the percentage of total sulphides in the feed is plotted as the vertical scale and the pounds of oil necessary per ton of feed is plotted as the horizontal scale. The curve had been drawn—or the straight line has been drawn, through these points in the way that was explained yesterday, and in the same way that the straight line was drawn of the relation between dilution and pounds of oil necessary. And the same relation shows, that is, that as you increase the richness of the feed to the flotation plant, other conditions remaining approximately constant, that the amount of oil necessarily increases. I have here also a curve plotted from the records of the Butte & Superior Mining Company, showing the same relation between the percent of zinc sulphide in the feed and the pounds of oil necessary.

I have also a curve of the Chino Copper Company, showing the same relation to exist between the percent. of sulphides in the feed and the pounds of oil used per ton. It will be noticed on this curve that at the right hand side there are four points which are apparently decidedly erratic; that is, they use a larger amount of oil than is apparently necessary for the

percentage of sulphide in the feed on those days; but on those four days the average dilution of the feed was higher than the average dilution on the other days; in other words there the dilution came in and raised the amount of oil necessary. Had the dilution been the same as it was, those four points would move right back onto or very near the straight line which has been put through as representing the relation.

I have next a curve showing the relation between the percent of total copper and iron and the pounds of oil used per ton of feed at the Ray Consolidated Copper Company. This curve was drawn to show the relation between the metal, rather than the sulphide, because the sulphide of course increases with the metal. Changing these figures to sulphide, would merely mean changing the vertical scale, but would not alter the slope of the curve, and it was rather more easy to calculate this thing, and not so many assumptions had to be made in counting the total copper and iron—no assumptions, in fact, had to be made in plotting those figures, while if we had attempted to change these figures into sulphide, some assumptions would have had to be made.

A definite relation exists between the total copper and iron and the percent of total sulphides of copper and iron, and the same relation will hold between the percent. of total sulphides of copper and iron and pounds of oil per ton of feed, and the amount of total copper and iron, in relation to pounds of oil per ton

Prof. Arthur Fay Taggart.

of feed. It still shows the tendency, that the amount of oil increases as the percentage of sulphide in the ore increases.

The same remarks hold in regard to the curve marked No. 3, of the Ray Consolidated Copper Company. I am again showing here the percent. of total copper and iron as against the pounds of oil per ton, this being from the slime vanner tailing plant, while the preceding one was from the concentration plant. Here the slope of the curve is very decided, and exhibits again this relation.

Now, in relation to these last two curves, I would like to call the court's attention to another confirmation of our idea—or of the fact that the amount of oil necessary for efficient concentration increases as the percent. of sulphide in the ore increased.

In the two tables which were presented by the Ray Consolidated Copper Company plant, we have the data given concerning the vanner concentrate retreatment plant and the slime vanner tailing plant. In the case of the slime vanner tailing plant the pounds of oil used per ton range from 1.82 as a maximum to .63, if I read this table correctly, as a minimum; in other words, somewhere in the neighborhood of one pound per ton as an average minimum efficient quantity of oil. The total percentage of copper and iron in the feed ranges in 2%—I think it is not necessary to pick out the maximum and minimum pounds of it, but all these figures are within a range of 2%; in other words, for one pound of oil that is used, the feed contains

about 2% of total copper and iron sulphide. Now, in the concentrate retreatment plant, the same kind of oil is used. The sulphides are of course the same sulphides, and the gangue present is of course the same gangue; in other words, here we have all conditions the same, except the amount of sulphide present in the feed and the amount of oil used.

In the vanner concentrate retreatment plant the total percent of copper and iron ranges from approximately ten to fourteen percent., and the amounts of oils necessary range from about 2.7 up to about 4 pounds; in other words, there, with all the conditions the same except these two variables, percentage of sulphide and pounds of oil per ton, we have this increase in the pounds of oil as the percentage of the sulphide increases.

It is necessary in any such comparison as this that the kind of oil and the kind of sulphide compared be kept the same. It is possible, as we all know, to treat Butte & Superior ore with one, two or three pounds of oil per ton. There is somewhere in the neighborhood of twenty per cent of sulphide in Butte & Superior ore. And, if we go down to the Utah Copper Company, where the feed in the slime treatment plant runs down in the neighborhood of perhaps one to two per cent sulphide in the feed, the minimum efficient quantity of oil there, certain kinds of oil, will be in the neighborhood of one or two pounds per ton, which would look like a contradiction; but, if the same oil and the same sulphide are used to-

Prof. Arthur Fay Taggart.

gether, that are shown in this Hayden plant, between the slime vanner plant and the concentrate retreatment plant, and in the relation shown in the curves, it is necessary then, other things being constant, to increase the quantity of oil as the percentage of sulphide increases.

MR. SCOTT: If you will hand me copies of those last graphs showing the relation of oil to sulphide, I would like to offer them so as not to get them confused.

I offer the graph for the Utah Copper Company, Magna plant, showing the relation between pounds of new oil per ton of original feed and percentage of sulphide in the feed, the same being based on data taken from the records of the year 1916, January 1 to December 24, inclusive.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 207.

MR. SCOTT: I offer the graph for the Butte & Superior Mining Company showing the relation between pounds of oil used per ton of flotation feed and percentage of zinc sulphide in the feed to flotation plant, same being based on data compiled from original records, month of November, 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 208.

MR. SCOTT: I offer the graph for the Chino Copper Company flotation plant showing the relation be-

tween pounds of oil used per ton of feed and percent of total sulphide in the feed, the same being based on data taken from the original records of vanner concentrate flotation plant, month of November, 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 209.

MR. SCOTT: I offer the graph for the Ray Consolidated Copper Company showing the relation of pounds of oil per ton of feed to the percentage of total copper and iron in the feed, the same being based on data taken from the original record of flotation slime vanner tailings plant, for the periods of ten days each during the year 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 210.

MR. SCOTT: I offer the graph for the Ray Consolidated Copper Company, Hayden plant, showing the relation between the pounds of oil used per ton of feed and the per cent total copper and iron, the same being based on data taken from original records of the vanner concentrate flotation plant for the ten day periods during the year 1916.

Graph admitted in evidence and marked DEFENDANT'S EXHIBIT 211.

MR. SCOTT: One question I would like to ask you.

Q. 22. In the first place, the dots are located on

Prof. Arthur Fay Taggart.

the chart, their position upward from the base line being determined by the dilution or amount of sulphide, as the case may be; and their position to the right of the other base line being determined by the amount of oil used?

A. That is right.

Q. 23. And the locating of the curve afterwards is a matter of mathematical conputation, after an accepted formula?

A. That is right.

Q. 24. Have you ever conducted any operations yourself using amounts of oil running into high percentages?

A. I directed a couple of tests at the plant of the Utah Copper Company recently concerning which I have the data here.

Q. 25. At which plant was that?

A. At the Arthur plant.

Q. 26. Will you just describe that operation?

A. The first one of these tests was in one of the regular Janney mechanical machines arranged 13 cells in series, taking the full feed, with no circulation.

MR. WILLIAMS: I think, if your honor pleases, that this is an exparte experiment.

MR. SCOTT: I willl have Mr. Frank Janney testify that he invited your representatives to see this test but they didn't come. It was during the time that your represen^t^atives visited Salt Lake.

MR. WILLIAMS: I know nothing about it; counsel knows nothing about it.

MR. SCOTT: They were invited to attend.

MR. WILLIAMS: Apparently here is something that was conducted at a plant while our representatives were present?

THE WITNESS: No, no.

MR. SCOTT: No.

MR. WILLIAMS: I don't really know what it is about, but it seems to me here is an effort to put in an exparte experiment.

MR. SCOTT: The offer was made to perform these tests in their presence while they were there, at the most opportune time to do it, for them.

MR. WILLIAMS: I reserve the right to object until I find out what is is all about.

A. This is a test run at the plant of the Utah Copper Company, the Arthur plant, on their machine called No. 1, which was a 13 cell Janney mechanical machine with two emulsifiers at the head of the machine, in the plant retreating vanner concentrates. The full normal feed of this particular machine was taken during the period of the test, and the middlings of the machine were not circulated. The duration of the test was one hour, and I made previous observations before starting this test to determine that representative results could be obtained in a run of one hour's duration—not the best results, but representative results. I have here some extra copies of this which I can distribute if you wish before the discussion begins. It will be noted that the heads or the feed to the machine ran 4.7 per cent total copper; that the feed

Prof. Arthur Fay Taggart.

contained 42.26 per cent solid; the tailings contained .8% copper; the concentrates contained 14.15% copper, 10.5 per cent iron, 52.50 per cent insoluble. The ratio of concentration was 3.42. The per cent of indicated extraction on the copper was 87.95; the pounds of oil added per ton 21.78; the reagent used was the so-called calura of the Utah Copper Company plant and the oils used were the viscous heavy oils of the standard Utah Copper Company oil mixture. In other words, they were a part of the oil mixture used at the Utah Copper Company which is labeled under certain circumstances as inert. The interesting part of the test then being that, using these so-called inert oils, which it has sometimes been assumed are added purely for the purpose of cheaply bulking the amount of oil used up to more than twenty pounds per ton, that even on so short a test as this it was possible to push the recovery up to 87.95. I have also here the record of another test that was made—

MR. SCOTT: I will offer this report produced by the witness of this operation just described by him.

MR. WILLIAMS: I object to the testimony of the witness in regard to this and to the report itself for the reason that it is shown to represent an experimental operation conducted at a plant at a time when our representatives were there and not conducted in their presence nor with any opportunity for them to observe and check up the results. It seems to me that there should be a limit placed upon this kind of experimenting, and that when the circumstances are such that

it could have reasonably been conducted with opportunities for inspection and it does not appear that there was any effort to so conduct it, that the testimony should be rejected as not worthy of consideration by this court or any of the courts that may follow it.

THE COURT: Well, does it appear that your representatives were there?

MR. WILLIAMS: Yes, and so far as we know it appears that they were very busy taking specimens, and couldn't give the matter any attention. There is no evidence of that either at all, no. It does not appear in evidence that our representatives were there. Nothing has appeared. It is all statements.

THE COURT: You are making an objection and stating facts that do not appear here.

MR. WILLIAMS: Then I say here is a test which—

THE COURT: Well, the particulars will all come out eventually, and for the sake of the record the court will allow this testimony to be introduced. He has already testified to it orally. If the circumstances are such that it should not receive any consideration the court will give it none. The objection will be overruled.

Report admitted in evidence and marked DEFENDANT'S EXHIBIT 212.

THE WITNESS: I have here another test that was run at the same time as the one just testified to. I will give you copies of the description.

Q. 27. This test represented upon this memorandum

Prof. Arthur Fay Taggart.

you have just produced was performed under your supervision, was it?

A. Yes.

Q. 28. And what plant was it performed in, and what machine?

A. At the Arthur plant of the Utah Copper Company, on the same machine as the previous test and on the same feed; that is, the vanner concentrate, using the full 13 cells of the machine, the full normal feed to the particular machine, and the middlings not circulated.

Q. 29. The material simply went through the machine from one end to the other?

A. Yes, and contrary to the usual practice in the plant, the middlings were thrown directly in with the concentrates, rather than being sent back to the Dorr thickeners and back to the plant for retreatment.

Q. 30. What was the reason?

A. In order to prevent building up an oil circulation in the middlings and consequently getting different results from those that would be indicated with the exact quantity of oil that we were adding.

Q. 31. In other words, giving back the exact quantity of oil you added, without increasing it through local circulation?

A. Yes, sir. In this particular test the feed came in at the rate of 460 tons per 24 hours, the copper in the feed being 4.875%, the feed containing about 42% of solid matter. The tailings ran .462% of copper, the concentrate 13.3% of copper, 10.2% of iron

and 39.2% insoluble. The ratio of concentration was 2.91, and the percentage of indicated extraction, based on the copper, 93.78. The reagent used was the so-called Calura, and the oil was the usual oil mixture of the Utah Copper Company Arthur plant when treating vanner concentrates, being 59% smelter fuel and 30% Jones oil—those are the heavy viscous oils—10% American Creosote No. 2, and 1% Yaryan pine.

The interesting part of this experiment or test is the amount of oil that was added per ton of ore, which was 249.83 lbs. The concentrates contained, by anaylsis, 491 lbs. of oil per ton, and the tailings contained by analysis 23.16 lbs. of oil per ton. During the conduct of the test I made continual observations as to the distribution of the froth on the cells and as to the character of the tailings from the machine. When this test was started the machine had been run for a considerable length of time previously without any oil being added, and the froth had died down on the surface of the cells until there remained nothing but occasional scattered bubbles on each and all of the cells. Very shortly—ten minutes after the oil was added, froth was appearing, a rather voluminous oily appearing froth was on the cells down to about No. 7. As the test progressed, the froth, a voluminous working froth, appeared on the cells on down in the machine until at the end of the test froth was being removed in considerable quantities, and when I speak of froth I am making a distinction as between froth and the stray bubbles that are present

Prof. Arthur Fay Taggart.

under ordinary operations on the later cells—Froth was appearing the full length of the machine. At the same time that that happened I had a s~~i~~ample taken of the tailing and examined the sample very carefully, first before any vanning had been done, and then I vanned down slowly, watching for oil in the tailing, and watching also most particularly for the so-called Cattermole granules which are agglomerates of sulphide particles. There was a large amount, as is obvious, of course, from the analysis, of oil in the tailing. I took the different particles of oil between my fingers and worked them over—There was no pretense or no appearance whatsoever of granulation and balling up into small agglomerates—but to assure myself that there was not any prejudicial amount of sulphide in this oil, I took the particles between my fingers and rubbed my fingers together and got no more grit from the oil than one will necessarily get if he takes some muddy water between his fingers; in other words, there was no semblance whatsoever of the Cattermole effect in the tailings of the machine.

The percentage of oil in the tailings assures us that in each successive cell throughout the machine there was contained more than 20 pounds of ore per ton of feed to that particular cell, and the frothing, which differed only in apparent oiliness throughout the machine—The first cell was of course the most oily appearing—and as we moved down the cells, the oily appearance decreased. Apart from that, and

apart also from the volume, there was no difference whatsoever in the character of the froth—I should perhaps say structure of the froth rather than character; there was some difference in the character if the richness should be so described.

Q. 32. Will you compare the froth which you have just described in the matter of structure with that which you have seen when the apparatus is operating on less than 1% of oil?

A. The structure was just the same of course; the bubbles consisted of films of contaminated water, containing solid matter.

MR. SCOTT: I offer the report produced by the witness of the operations just described by him at the Arthur plant of the Utah Copper Company. I may state that we will produce Mr. Janney, as I said before, who will testify that he invited the representative of the plaintiff to see a test such as described by the witness~~es~~, but, in order to remove all misunderstanding, we now offer to repeat this test for their benefit and in their presence, with access to all of the details and every opportunity to check it.

Report of test No. 2 admitted in evidence marked DEFENDANT'S EXHIBIT No. 213.

MR. WILLIAMS: We accept the offer of the defendant, because that seems to be the only solution. These are very interesting and perhaps instructive tests, if we can find out all about them.

MR. SCOTT: We have a witness who will testify

to still another test, and we extend our invitation to cover that also, a test at the same plant, or anyway in the same town. I think it is at the same plant.

THE WITNESS: Yes, at the same plant.

MR. WILLIAMS: So that can all be done in one trip?

MR. SCOTT: Yes. You may cross examine.

MR. WILLIAMS: I think as far as these particular tests are concerned, your honor, that the right to cross examination had better be deferred until we have seen them repeated and know about them.

THE COURT: I am beginning to think that this case shows no prospect of ever ending, if witnesses are called and recalled and transferred to Utah to make tests and come back again.

MR. SCOTT: Maybe they could do that over Sunday, your honor, so as not to delay matters.

THE COURT: Proceed.

MR. GARRISON: Your honor is not going to make us cross examine on these tests held not in our presence?

THE COURT: Is this the way patent cases are usually tried?

MR. GARRISON: I think not, your honor.

MR. SCOTT: I only extend this invitation as to this particular test in the interest of peace. Mr. Janney invited these representatives to see this, and they said they could not stay over to see it.

MR. KREMER: Wasn't Professor Fulton your representative?

MR. WILLIAMS: Professor Fulton was one of our representatives.

MR. KREMER: He was invited to attend this test.

MR. WILLIAMS: Just about the time he was going to take his train.

MR. KREMER: I don't know anything about his train; he was invited.

MR. GARRISON: That is not the important matter. Professor Fulton had no authority to attend this test. Counsel governed these matters, and he had to get back to be present the next morning in court. Now, to be fair and to have all the testimony brought in that ought to be brought in, I assume that these tests are relevant and important points in this case. If not, they should not be admitted to it at all. They are, however, self-serving declarations by these gentlemen who get up and qualify as experts here, but whether they have knowledge of what they are going to do—They bring in things written on a paper which are utterly un-cross-examinable by us, and they produce what they assume to be proper testimony. I conceive that nothing could be less productive of fairness and nothing could put the other side at a greater disadvantage than we are put in this matter.

It of course deserves no special credit on our side that we have not been captious. We realize that this case is of great importance; that in its various aspects it has been to the Supreme Court of the United States and before other various high courts of jus-

Prof. Arthur Fay Taggart.

tice in this country. We realize that your honor does not intend to exclude any evidence which, by any possibility could have any bearing—any proper bearing on the issues in this case, and with that view we sympathize; we do not want this case tried so that any court of law which passes upon it has any doubt—

THE COURT: Is it your opinion that such evidence should not have been admitted?

MR. GARRISON: Should not have been admitted at all, sir. I should like to speak of that if it was not a ruling that your honor has already made.

THE COURT: Well, have you not said that you intend to put in some test of this kind?

MR. GARRISON: No, sir; we do not propose to put in any test not made in the presence of the court, do we, Mr. Williams?

MR. WILLIAMS: We propose to put in none that were not made in the presence of the opposing parties, and as far as we know we do not propose to put in any tests except those made in the presence of the court.

THE COURT: These tests and experiments close to the beginning of a trial, I imagine are not entitled to very much weight. I think there is a case in the Supreme Court where they virtually intimated that they should not be accepted, especially if they were made out of the presence of the other party, and samples were not taken.

MR. GARRISON: Yes, sir; I was just going to call your honor's attention to that.

THE COURT: And I think that the court should say something about it, for fear they should be held competent further along the line.

MR. GARRISON: Exactly; if they are incompetent we are absolutely confronted with these figures, not knowing anything about them, or what the ingredients might have been or anything, and we simply can not cross examine about them.

THE COURT: The court has admitted these things with the statement that if the court thinks it is not entitled to consideration, it will get none. But I may make up my mind later on that these things are entitled to consideration. The plaintiff, however, can not say the court thinks them entitled to consideration, and I can see how that would be.

MR. GARRISON: The first case that I ever tried, I relied upon the first point and thought that I was perfectly safe on the second point. The court held with me or my first point and against me on my second point, and threw me out of court, and I have been rather wary ever since. We think these tests should be excluded; they were performed out of our presence and without our being advised of what was done. If your honor is willing to adjourn court sufficiently long for them to conduct tests in our presence at certain places, we will submit to that ruling, and of course, I want to suggest very earnestly to your honor the impropriety of permitting evidence of this kind, which there is no way for us to check.

Prof. Arthur Fay Taggart.

THE COURT: On what theory do you offer it, Mr. Scott?

MR. SCOTT: It is the universal practice in patent cases to hold that, whether an experiment is exparte or inter-parte goes to its credibility only, and has nothing to do with its admissibility; and where the other side are invited to attend, and either do or do not, even the element of credibility is removed from the situation altogether.

THE COURT: The invitation to a mere employe four or five hundred miles away would be hardly sufficient.

MR. SCOTT: They were there for the express purpose of investigating the operation of this plant.

THE COURT: Well, it stands in the record, and you will be given an opportunity to meet it. If you can not meet it, of course the court takes that into consideration, but certainly there must be a limit. You are not to keep the court waiting while different sets of witnesses go from here to Utah to carry on tests and report back about them, and the other side must come back and check them up. We will never get through here at all at that rate. The year's work of the court will be dislocated completely. I appreciate that you must have all the time necessary to try this case, but that does not mean that you may have all the time that you think is necessary. There is quite a distinction there.

MR. KREMER: The offer was made, and the objection was interposed that they did not have the

opportunity to check the test, and we made the offer to repeat it, and they accepted it.

THE COURT: Well, the court has something to say about that; it has not surrendered the entire control of this case to counsel.

MR. KREMER: I appreciate that, but they have about 14 men whose names were presented here, any one of whom could go there and inspect it. I don't think it is going to delay the trial at all.

MR. GARRISON: I would like your honor to rule upon the question of the competency. This witness has not shown that he knows how much tonnage was put into the machine or how much oil or how much calura, or anything else; he has not qualified as a metallurgist; and yet he comes here in person and offers testimony which covers a plant half as big as this court house, and pretends to know just what took place at every point in that plant,—and if he does not know, his testimony is not competent—

THE COURT: What are the qualifications which this witness gave; it has been some time ago.

MR. GARRISON: He has not qualified as a metallurgist. He tells the amounts of the heads and tails and tonnage; he tells the amount of acids and insolubles and all that in his own person. He is an entire concentration of the apparatus of that plant upon this most critical day. Now, if that kind of testimony is admissible, the rules heretofore governing the courts upon the character of evidence that can be given in court are all wiped out. This is the rankest hearsay,

Prof. Arthur Fay Taggart.

and yet we are met with his bald statement that, in respect to very important points in this case he is going to lay down certain dicta, which, unfortunately for us, cross examination can only cause him to reiterate and emphasize.

THE WITNESS: I think I can qualify, your honor, in the ways that the gentleman questions.

MR. SCOTT: The witness has already qualified.

THE WITNESS: I also observed the weighing—

MR. GARRISON: One moment, please. I am not arguing this case with the witness; I am arguing it with your honor.

THE COURT: Well, I allowed the witness to testify at length as to what were his qualifications originally.

MR. SCOTT: He testified to having an education in mining engineering at Stanford University, to several years' practical experience in his profession—

THE COURT: These facts that he is testifying about now appear, and if he is not qualified to testify to those, it will be enough to show on cross examination whether he is qualified or not.

MR. GARRISON: I understood his testimony to be that he had been at plants before flotation was introduced.

THE COURT: With reference to the fact, does he know how much oil and other things were used, and as to the analysis, etc.? Both parties have allowed that to go in from the beginning. I don't know about this. You can develop it if you can.

Prof. Arthur Fay Taggart.

CROSS EXAMINATION,

BY MR. WILLIAMS:

X-Q. 33. What knowledge have you as to the feed that entered the flotation plant at the operation which you called test No. 1?

A. As to what particular characteristic of the feed, Mr. Williams?

X-Q. 33-A. What knowledge have you of that feed—not information, but knowledge?

A. As to what particular characteristic?

X-Q. 33-B. Well, what do you know about it.

THE COURT: He is proceeding to tell.

A. I know as to the quantity in so far as the tonnage sample, which is the ordinary method of determining the quantity, will tell. I watched the tonnage sample taken; I watched the weights taken off the scales, I watched the timing.

X-Q. 34. Then what was done to those tonnage samples afterwards in your presence?

A. The tonnage samples were dumped from the pan on the scales to the launder underneath the scales.

X-Q. 35. Well, then, what further did you see being done with that tonnage sample.

A. Nothing.

X-Q. 36. And yet you come here and say that the headings contained a certain proportion of solid, a certain amount of sulphide, and a certain amount of carbon—is that what you mean there?

Prof. Arthur Fay Taggart.

A. No, sir.

Q. 37. What is that "carb"?

A. That stands for carbonate.

X-Q. 38. Now, where did you get all this knowledge from?

A. That was reported from the assay office.

X-Q. 39. Did the assay office tell you what the condition of the water was in which that ore was diffused?

A. As to what particular characteristic?

X-Q. 40. Was it pure water or was it water charged with a modifying agent?

A. It was water containing a very small quantity of contaminant in the shape of—which was determined —in the shape of oil. The Dorr tanks—or at least this machine had been run without return to the Dorr tanks for several days preceding this test at my direction in order that the amount of contaminant in the pulp going to the machine could be reduced as greatly as it was possible to reduce it. It is not possible to get it down so that there yet remained no trace of oil; but as I recollect, and I can produce assays if you so desire, the amount of oil in this feed coming to the machine was down in the neighborhood of one pound per ton of feed by assay. And I considered that as I was going to add somewhat more than 250 pounds of oil—

X-Q. 41. No, we are on No. 1.

A. I see. As I was going to add somewhat more than twenty pounds of oil per ton to the feed that that wouldn't make any difference.

Prof. Arthur Fay Taggart.

X-Q. 42. You think, having in mind the sequence of the operation and observing that the twelve and a half per cent—we will take it as twelve and a half per cent round figures?

A. Yes, sir.

X-Q. 43. Now, the twelve and a half per cent operation was carried on first?

A. Yes, sir.

X-Q. 44. From 7:45 to 8:45 p. m.

A. Yes.

X-Q. 45. And this determination that you speak of and that you have not given us of the pound of oil in the feed water, that relates to that first operation, does it not?

A. And relates also to the second. We were sampling along in there right straight ahead in order to find out—to try to find out when that tank was ever going to get down to a point where it wasn't carrying a small amount of contaminant.

X-Q. 46. Immediately after you did your twelve and a half per cent operation which loaded up your machine with oil, you did this 1.08 per cent operation?

A. Yes, sir.

X-Q. 47. Which followed it by some forty-five minutes?

A. Forty-five minutes, yes, sir.

X-Q. 48. What provisions did you observe between these two operations to remove that contaminated amount of oil that had flowed through the plant at the end of the operation which is marked test No. 2, and which ended at 8:45 p. m.?

Prof. Arthur Fay Taggart.

A. We stopped feeding oil to the machine, flooded the machine with water and scraped froth off until no more froth appeared than scattered bubbles, throughout the full length of the machine, and then having brought the water down again to the point that the cells were not overflowing as to allow an opportunity for the froth to collect if it would collect, we ran machines in that way and found that no froth collected. In other words, there was not enough oil present in the feed, this small amount which I have mentioned shown by the assay, to cause any frothing or collection.

X-Q. 49. That is to say there was not enough there to form any froth until you added your 1.08 per cent of the heavy oils and then it formed a froth?

A. Well, of course that is a way to put the question. I will answer it by saying that there was not enough there to form a froth; that there was not enough there to form a froth when small quantities of the mixed oil was added, because such tests were made at another period of my stay down there to determine whether 1.6 pounds of this mixture would do any work at all, and we discovered that it would not, and so there was not enough oil there even to do any work when this final mixture was added. Consequently I stand on this test marked No. 1, and on the statement that the effective part of the collecting agents and frothing agents present in that test was the 21.78 pounds of oil consisting of 66% smelter fuel and 34% Jones.

Prof. Arthur Fay Taggart.

X-Q. 50. That is to say, in your opinion, all the work resulted from 1.08 per cent of the heavy oils and nothing resulted from the presence of something over a pound per ton of the dissolved frothing agent?

A. Yes, sir.

X-Q. 51. And the test that you have numbered No. 2 was the first test that you made?

A. Yes, sir.

X-Q. 52. And the test that you have numbered No. 1 was the second test that you made?

A. Yes, sir.

X-Q. 53. Three quarters of an hour afterwards in the same machine?

A. These are renumbered for the convenience of the stenographer. The original number of these tests, if you would like to have them, were—the test which is No. 1 was No. 10, and the test which is No. 2 was No. 5. I have the data here in my notebook if you would like to see it.

X-Q. 54. That is to say you made some eight other tests?

A. Yes, sir.

X-Q. 55. Which you did not think it was worth while to bring here?

A. No, sir; we considered that we would be encumbering the record with repetition. There were quite a few data presented in the early days—I mean of the testimony, which I asked to see, as I wanted to see how these things were working, and we went down and ran a series of tests, which were purely confirma-

Prof. Arthur Fay Taggart.

tory, as it were, of tests described in the previous testimony and we didn't think it necessary to encumber the record. If you like, however, I have the data on these tests and can produce it.

X-Q. 56. Now you said that you had the analysis of the water?

A. Yes, sir, I have it,—I haven't got it here, but I can get it. These water samples were taken right straight ahead and are on the records of the Utah Copper Company during the time this work represents. I will send for them it you would like them.

X-Q. 57. You haven't a specimen of the water, of course. You didn't take a specimen that you can give us?

A. No, sir.

X-Q. 58. And all of the assays that are given here are the assays as they were given to you; you didn't make any of them yourself?

A. Oh, no, no.

X-Q. 59. In fact, there was not a quantitative determination on these exhibits 212 and 213 that you made yourself?

A. Why, no.

THE COURT: Now, have you the stipulation?

MR. SCOTT: I will read the stipulation which was entered into.

(Whereupon counsel read the stipulation previously entered into.)

MR. GARRISON: I drew that stipulation, and it seems to me I am entitled to state what I meant by it.

Prof. Arthur Fay Taggart.

I meant by the first part to limit the testimony entirely, as its language does, to testimony regarding operations at the Butte & Superior. I intended the latter to be confined, as its language seeks to, and I believe does confine it, to regular operations, such as those that have been admitted here and testified to by Mr. Engleman and other witnesses as mill superintendents, to which testimony I first made the objection that they had not their original reports with them. And this was intended to obviate the necessity of their bringing the original slips of paper upon which these reports were made. The language is: "Provided that either party may produce witnesses as to regular operations." Now, this, I consider, was not a regular operation. It was something carried on by this gentleman under his direction after several days of preparation and was in every sense of the word a test, and a test carried on out of court without any opportunity for us to be advised of what was about to be done and without any opportunity to take samples or to inspect or be present when the oil was going in or when the acids were going in, all of which things are matters of primary importance. If this gentleman was advised by some one standing at the oil spigot that they were putting in twenty pounds, he has to rely upon that, that is all he knows about it. If that person should turn the spigot off for a fraction of a minute, the operation is entirely different from what he thinks it is. This witness can, with entire honesty, testify to different things—

Prof. Arthur Fay Taggart.

THE COURT: I understand your point. Of course, you have your stipulation here. That represents it.

MR. SCOTT: Counsel's remarks that he intended this to extend only to regular operations and not to special or test operations, is not in accord with the acceptance and interpretation that has been given to this stipulation. These reports which have been introduced by these other witnesses without objection, after this stipulation from counsel, include test operations, operations to find out what will happen under this condition and under that condition, when this ingredient of the oil is omitted, and that when that ingredient of the oil is omitted. These things already received under this stipulation without objection from counsel include operations with extraordinary amounts of oil; and that is the only respect with the regard to which the present witness is going to testify that these operations differed from the ordinary operations, in exactly the respect that the evidence already introduced differs. What this stipulation means, it seems to me, is to be ascertained by how it has been accepted in this court, and how counsel have accepted it, not by what they say now, after both parties have acted upon the stipulation for two weeks.

MR. GARRISON: With respect to that, what has happened has been that when any one of these various allied companies have chosen to operate their mill for a series of days in a particular way, that becomes the regular operation of that mill for those days or weeks

that they were so doing. It is an entirely different thing from a little experiment carried on by this witness under the circumstances here detailed.

MR. SCOTT: There is one of these reports, your honor, which is a report entitled "Abnormal operations" and for the purpose of determining abnormal profits as distinguished from normal profits. Confessedly they are not, upon their face, what counsel denotes as "regular operations".

MR. GARRISON: That seems to be building up a principle of law upon the leniency of the parties upon the other side, which cannot be done.

MR. SCOTT: You have waived that by stipulation.

The Court: Well, this stipulation, in its language, certainly contemplated regular operations and the result commonly understood as such, when regular records are kept as permanent files of the company. If they have departed from that somewhat, ~~you have departed from that somewhat~~, you have the benefit of that so far as it has gone, but I do not think it binds them continually. Personally, speaking as a court, I am inclined to doubt whether there is very much value to testimony of this character, experiments made while the litigation is pending, and as counsel says by allied companies, whom we can guess are confronted by somewhat the same condition as the defendant here, the same situation. And then, again, you were conducting these experiments twelve years after the patent and after three or four or five years of its prac-

Prof. Arthur Fay Taggart.

tical working operation, when machinery and mechanical operations have been improved from day to day, when things have been made possible now, no doubt, that would not have been possible when this patent was granted and applied for. At the same time, the court has felt that such testimony might serve a limited purpose, as indicated in its various rulings, but at this time, this testimony in the court's judgment does not come within this stipulation, and in the face of this objection that it is hearsay, the court is bound to sustain it and will sustain it in reference to these last two experiments testified to by this witness. I think we are on the safe side.

MR. SCOTT: We will bring the assayers and everybody else to prove it.

MR. KREMER: I would like at this time to clarify the record by inquiring of counsel particularly if the stipulations in the Hyde record, the whole record being stipulated in, is not a stipulation in this case? It will guide us in our conduct, when it comes to the presenting of their case, because if we are not going to be found—if they are not bound by the stipulation in the Hyde record, certainly we are not, and we of course will object—I am making this statement for the purpose of expediting matters, giving due notice so there will be no controversy when the question arises when their case is presented. If we are to be bound by the stipulations in the Hyde case, and we have thought we were bound by them, then it is unnecessary to present to this court, under that stipula-

tion, the assayer and the gentlemen who made an analysis. We stipulated in this case that—correct me, Mr. Williams, if I misstate this, because I am stating it solely from memory—that assays should be received as presented on their verity unless specially challenged. Am I not correct in that? There isn't even that exception, Mr. Scott calls my attention to.

MR. WILLIAMS: We will have the stipulation. There is a stipulation in the Hyde case and I understand that stipulation binds us in this case. We will start with that. There were several stipulations in the Hyde case but that stipulation—

MR. KREMER: If that is going to bind us it must bind them.

THE COURT: Well, find your stipulation. That is what we are looking at right now.

MR. GARRISON: I have based none of my objections upon the assays.

MR. KREMER: The objection was it was all hearsay.

MR. GARRISON: I said nothing, sir, in any of my remarks about assays. This is the first time the matter of assays has been mentioned. I said it was hearsay as to the amount of oil that went in and as to various other matters that this gentleman testifed to, and I omitted everything about assays. I am perfectly willing to admit assayers' reports without the necessity of bringing them here.

MR. KREMER: There is no essential difference between an assay for a mineral and an assay for oil; it is all assay.

Prof. Arthur Fay Taggart.

MR. GARRISON: I have not said a word about objecting to anything on the ground of assay. I am talking about the amount of oil that goes in to the mixture, which is not subject to assay at all. It is subject to standing at the spigot and seeing it go in. I myself stood at one of these mills and saw the spigot turned off and on. Whether it is turned on or off depends on a physical fact which can only be testified to by witnesses who were present and saw it. An expert is no more competent to testify what was happening on a floor above him than I am and I am not an expert.

MR. KREMER: That is very true as far as it goes, but the only thing we are concerned in is the amount of oil that went in, and watching it go in is not the only way to determine that fact. An assay will determine its presence just as well as could be told at a spigot. We are certainly not called upon to discuss such an elementary proposition as that. Therefore, as this stipulation covers assays, it must cover all assays or it will cover none.

MR. SCOTT: Here is one stipulation appearing upon page 70, by Mr. Williams: "It is noted that the tests above described by the witness, not having been made in the presence of opposing parties, the observations and conclusions of the witness are objected to as not the best evidence unless an opportunity is afforded to complainants to repeat these experiments by supplying the complainants with sufficient quantities of the ores used in the condition in which

they were used in these experiments, and also, if necessary, of the other reagents. With this reservation, no objection is made to the assay figures upon the ground that the man who made the assays is not produced as a witness." Further that is put in in a more formal shape.

MR. KREMER: We had a stipulation made preceding Dr. Chandler's testimony.

MR. WILLIAMS: I think what Mr. Scott has read was the first appearance of a stipulation in there. The general understanding was that if the assayer who was known and whose work would be deemed acceptable to both parties did the assaying why he would not be called upon to testify. There may have been something in Dr. Chandler's testimony by reason of the fact that some one assisted him in the assay.

THE COURT: The court has ruled. You may proceed.

MR. KREMER: Exception.

THE COURT: It will be noted.

MR. KREMER: Your honor, I do not know—for the purpose of information, your honor has ruled this entire testimony out, do I understand that?

THE COURT: These two tests that the witness has testified with respect to.

MR. KREMER: Will your honor permit us, so as to furnish a full statement of the record there—I don't know whether it would be necessary to submit a further offer to prove than that which appears in the record.

Prof. Arthur Fay Taggart.

THE COURT: If you desire.

MR. KREMER: If so we will ask leave to submit it.

MR. WILLIAMS: Now, I will cross examine the witness on the subject of curves.

X-Q. 60. On exhibit No. 202, Utah Copper Company, Magna plant, No. 1, I find along the bottom of the chart the numbers are 10.0, 12.5, 15.0 and so up to 55, which is the last number and apparently 60, as the value of the last vertical line, and this is entitled "pounds of new oil per ton of original feed." Now, first, please tell me what is the table from which this chart was made?

A. That was made from this Utah Copper Company, Magna plant, Metallurgical Department, vanner concentrate flotation plant, September, 1914, to December 24, 1916, inclusive, and on looking at this exhibit 195 I see that the pounds of oil per ton do not correspond at all.

X-Q. 61. Is that in error?

A. I noticed that the draftsman apparently in copying moved the decimal point one point to the right. If you will move the decimal point one point to the left it will give you 1.0, 1.25, 1.50, 1.75, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0 and 5.5, and now the abscissae are correct. That changes of course in no way the relations expressed that the quantity of oil required increases as the amount of water in the feed increases.

X-Q. 62. Now, let us take curve No. 2, Utah

Copper Company, Magna plant, Exhibit No. 207. As I understand it, or as I read the curve, when the feed contains 24.2% of sulphides in the feed, no new oil is required. Does the curve show that?

A. That most certainly would be a proper reading of this curve as an average.

X-Q. 63. That is to say you could operate without oil under those conditions?

A. No, I did not say that; I said that was a proper reading of that curve.

X-Q. 64. Then, that being a proper reading of the curve, the curve shows that as average, you can work without oil, is that correct?

A. The curve shows that, as an average, the amount of new oil per ton of original feed increases as the percentage of sulphide in the feed increases. Just as you can not predict from a curve of average life, that you are going to live to the age of average life.

X-Q. 65. I appreciate that fact.

A. The same thing here.

X-Q. 66. The same way in summer; if the mean average temperature of the month is 60, and a frost comes along and kills all the crop, you could not have predicted that frost from the mean average temperature?

A. Certainly not, but you can predict what the mean average temperature for the month is going to be, and in the case of life insurance you can pre-

Prof. Arthur Fay Taggart.

dict with sufficient accuracy to invest large sums of money on your prediction.

X-Q. 67. But your sums of money would not be invested unless you had so many of the variances that the average would be a reasonable basis for your prediction?

A. Of course not. No curves are useful unless that is the case.

X-Q. 68. So that all that you have determined is, as far as these tables show, that there is, in all the variances for a certain day, a sort of average of these variances along the line that you have indicated?

A. Why, certainly; that is all you can expect from mill operations. These particular variations are much more impressive from the fact that, notwithstanding all the unavoidable variances in mill operations, due to the ignorance of operators and so forth and so on, that this big general trend shows up through the record; it is extremely impressive. If we should show these things with laboratory machines, where we could personally say that we are going to vary these two things only so much, and hold everything else absolutely constant, that of course would be confirmatory, but it would not be so impressive as this, where, notwithstanding all these variances which are without control, this great general trend shows throughout.

X-Q. 69. Now, taking this average as a basis, I have followed your curve down to zero, and we reach the conclusion, I think, that we should not continue to represent the variations beyond zero.

Prof. Arthur Fay Taggart.

A. Of course it is a rule of all empirical calculations, that you should not carry them beyond the range of the data on which they are based. Nobody carries them beyond the range of the experiments from which he develops the curve; that is well recognized in all engineering.

X-Q. 70. That is to say, these curves represent only the average of these experiments?

~~X-Q. 70. That is to say, these curves represent only the average of these experiments~~?

A. Exactly so. We can not carry any empirical law based on experimental data beyond the range of the experiment upon which it is based, or the results upon which it is based; but throughout those results, throughout the range of those data, this curve represents the law.

X-Q. 71. And it seems to enforce the conclusion, does it not, that if, under similar conditions except the amount of oil, you change this average of about four and a half pounds of oil to twenty and a half pounds of oil, you are wasting oil, does it not?

A. Why, I think so, yes. I think we could most certainly have operated this—However, I think I had better correct that. If you can sufficiently increase your recovery to pay for the oil, then you are not wasting it. The matter becomes there one, however, of commercial operation, and other factors enter. If

P. 3584, L. 28, insert " rather than one of scientific technical operation " after " operation,"

Prof. Arthur Fay Taggart.

it is not wasted. If the reverse is the case, then it is wasted.

X-Q. 72. And if, by increasing the amount of oil you reduce the grade of your concentrates and diminish your recoveries, you would have to say that you are wasting oil?

A. If you decrease the net return to the company, you are most certainly wasting oil.

X-Q. 73. You mentioned a formula of Steinmetz for passing a curve through a set of empirical data. Can you give me a reference to the Steinmetz publication which decsribed that?

A. No, sir, I can not.

X-Q. 74. Or any idea where it is to be found?

A. Why, I don't even know that. The thing goes so commonly by the name of the Steinmetz method of putting a curve through experimental points, that I have never taken occasion to look it up. I learned it when I was in college myself, and it has been called Steinmetz method, as I recollect, ever since. I can furnish you a reference, if you desire, by writing back to New Haven to men who are dealing more particularly with the actual teachings of mathematics, and get it that way.

MR. WILLIAMS: That is all, at present.

WITNESS EXCUSED.

FRANK G. JANNEY, recalled for further

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Mr. Janney, did you have any communication with representatives of the plaintiff when they were in Salt Lake City and Garfield about a week ago?

A. I did.

Q. 2. And what was the nature of that communication and whom was it with?

A. I called Dr. Fulton by phone at the Utah hotel, and told him that we were conducting some experiments at the Arthur plant that I thought would be very interesting to him, and I asked him if he would like to come out and witness them. He said that he would discuss it with Mr. Chapman and let me know later. About 30 minutes later he called me on the phone and said it would be necessary for them to leave on the afternoon train for Butte, and that they would be unable to come out.

Q. 3. What day was this, Mr. Janney?

A. It was Sunday, the 22nd of April.

Q. 4. And about what time of day?

MR. WILLIAMS: If your honor please, it does not seem to me that this testimony is relevant to any matters that are of record. Here is the fact: it is true, Professor Fulton and Mr. Chapman, who are not of counsel, happened to be in Salt Lake City, and Mr. Janney telephoned to them and said "I would like

Frank G. Janney.

to have you come out—" and it was late in the evening apparently.

Q. 5. MR. WILLIAMS: It was in the evening, was it not, that you telephoned?

A. It was in the morning.

Q. 6. What morning?

A. Sunday morning about eleven o'clock.

MR. GARRISON: The experiment had then taken place.

MR. WILLIAMS: The work of inspecting the plant had been finished. Counsel were not present, and they were under no direction from counsel, and counsel did not know of that fact until now in court, and the whole thing is now irrelevant and immaterial and we move to strike out the answer.

MR. KREMER: I asked counsel the direct question if Mr. Fulton was their representative. Previous to that question being propounded the objection was interposed that their representatives, being then in Salt Lake City, were not advised of these experiments or given an opportunity to witness them, and I asked if Professor Fulton was their representative and he said he was.

MR. WILLIAMS: One of them.

MR. KREMER: One of them.

THE COURT: What could one man learn from such an experiment if he were there? He could see only one part of it at a time. There would be many other parts and factors involved, of which he could not keep any check in a mill operation of that sort.

MR. KREMER: One man would be the man who would supervise the operation, and one man could supervise the observation.

MR. GARRISON: These experiments took place on Saturday, your honor.

THE COURT: The motion to strike will be granted.

Defendant excepted.

WITNESS EXCUSED.

MR. KREMER: Mr. Williams asked Mr. Engleman to have a number of reports and data prepared for him. Mr. Engleman now has some data to supply to Mr. Williams, but before doing so Mr. Engleman, I believe, desires to correct something in his testimony.

MR. WILLIAMS: His testimony of yesterday?

MR. KREMER: I don't know; he just mentioned it to me when he said he had these papers for you.

EDWARD W. ENGLEMAN, recalled for further

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. MR. WILLIAMS: I will ask the witness what page was the correction?

A. Page 1192—Well, 1191, really. Question No 138 we will have to start with.

Q. 2. BY MR. WILLIAMS: Proceedings of April 28th?

Edward W. Engleman.

A. April 28th.

Q. 3. You may make any correction that you have to make.

A. We will have to start with question No. 137 in order to get the complete understanding: "Q. Now, we will take the record for February 11th, 1917. A. Treated 463 tons heading, 456 tons tailings, 7 tons concentrates; 85.68 lbs. coal tar, 18.50 lbs. per ton of material treated. Q. 138. Now the assay. A. .680% copper in headings; .453 copper in tailings; 14.46 copper in concentrates; 50.20% insoluble; 7.20% iron." Now—

Q. 4. Now, do you go further?

A. Yes, sir.

Q. 5. I will read it: "Q. 139. Before I leave this particular plant what did you do with the material—What did you do with the kind and grade of material that you treat in this plant, before you installed it? A. This material was treated on our big permanent installation. Q. 140. What kind of concentration? A. Flotation concentration. Q. 141. No, before you had flotation. A. This material was going to waste. Q. 142. Now, in other plant for retreating vanner concentrate products, is that right? A. Yes"—Is that all you want?

A. Yes; that is the part I wanted to correct. We did not send this product to waste. It was treated by the smelter.

Q. 6. What you have given as vanner concentrates?

A. The vanner tailings went to waste, but the vanner concentrates did not go to waste before flotation.

Q. 7. The vanner concentrates went to the smelter and the vanner tailings went to waste, is that right?

A. Yes, sir.

Q. 8. MR. KREMER: Is there anything else?

A. Why, I have some data here that was missing on the sheet presented.

Q. 9. I mean that you wanted to correct?

A. No.

MR. KREMER: The paper is a tabulation of some matters requested by Mr. Williams on cross examination, entitled "Ray Consolidated Copper Company, data compiled from Monthly State—" etc. We offer it in evidence.

Table admitted in evidence without objection marked DEFENDANT'S EXHIBIT 214.

Whereupon further hearing was adjourned until 2 p. m.

2 o'clock p. m. May 2, 1917.

MR. SCOTT: In order to simplify matters and to avoid unnecessary taking up of time, I would like to get clear myself—Possibly the rest are clear but I am not—just exactly the grounds of the court's ruling in excluding the testimony of Professor Taggart. As I understood, the plaintiff's objection was on the ground that the experiment was ex-parte; whereupon we of-

fered to repeat the test and that was accepted
came an objection, as I understood it, on the
that the evidence was hearsay, the witness no
personal knowledge of everything that had tak
and when that objection was raised there wa
cussion upon the subject of assays, and as
stood, counsel for the plaintiff stated that
not insist upon proofs of assays. Now, as
have been able to sift it out, that seems to re
grounds that are relied upon to the weighin
headings and the tonnage of headings and so
just what is left I don't know.

THE COURT'S ruling was on the theor
developed that he had not sufficient persona
edge of all the factors that were connected
operation to speak of them other than by
that was all I had in mind at the time.

MR. SCOTT: That is the way I unders
court's ruling, but as I further understoo
think I am quite correct, counsel signified t
had no objection to accepting assays.

THE COURT: I think you have a stipu
that effect; wasn't one read?

MR. SCOTT: The court ruled that th
not regular operations but rather experiment
tions of the mill.

THE COURT: When that matter came
the ruling was made, this testimony of Profes
gart was held not to be within such stipulatic
some one or both of them mentioned stipul

Q. 7. The vanner concentrates went to the smelter and the vanner tailings went to waste, is that right?

A. Yes, sir.

Q. 8. MR. KREMER: Is there anything else?

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MR. KREMER: The paper is a tabulation of some matters requested by Mr. Williams on cross examination, entitled "Ray Consolidated Copper Company, data compiled from Monthly State—" etc. We offer it in evidence.

Table admitted in evidence without objection marked DEFENDANT'S EXHIBIT 214.

Whereupon further hearing was adjourned until 2 p. m.

2 o'clock p. m. May 2, 1917.

MR. SCOTT: In order to simplify matters and to avoid unnecessary taking up of time, I would like to get clear myself—Possibly the rest are clear but I am not—just exactly the grounds of the court's ruling in excluding the testimony of Professor Taggart. As I understood, the plaintiff's objection was on the ground that the experiment was ex-parte; whereupon we of-

fered to repeat the test and that was accepted. Then came an objection, as I understood it, on the ground that the evidence was hearsay, the witness not having personal knowledge of everything that had taken place, and when that objection was raised there was a discussion upon the subject of assays, and as I understood, counsel for the plaintiff stated that they did not insist upon proofs of assays. Now, as far as I have been able to sift it out, that seems to reduce the grounds that are relied upon to the weighing of the headings and the tonnage of headings and so on, and just what is left I don't know.

THE COURT'S ruling was on the theory that it developed that he had not sufficient personal knowledge of all the factors that were connected with this operation to speak of them other than by hearsay; that was all I had in mind at the time. The

MR. SCOTT: That is the way I understood the court's ruling, but as I further understood, and I think I am quite correct, counsel signified that they had no objection to accepting assays.

THE COURT: I think you have a stipulation to that effect; wasn't one read?

MR. SCOTT: The court ruled that those were not regular operations but rather experimental operations of the mill.

THE COURT: When that matter came up, after the ruling was made, this testimony of Professor Taggart was held not to be within such stipulation. Then some one or both of them mentioned stipulations in

the Hyde case, which are a part of this trial. Now, how far those stipulations go, I am not advised.

MR. SCOTT: I wanted to be clear about whether this matter of the assays was waived, or whether we would be obliged to support this testimony by the individual assayers who performed the operation; and if counsel will state that, it will clear things up and simplify the further proceedings.

THE COURT: If you are not in accord about it—about what the stipulations cover, the court will have to rule on it.

MR. GARRISON: I don't know what the stipulations contain, myself.

MR. SCOTT: We will proceed upon the assumption that all assays must be proved hereafter, and all other details, and we will so be governed.

MR. WILLIAMS: There is no ground for that assumption.

MR. GARRISON: I was waiting for Mr. Scott and Mr. Kremer to finish. What I said was that I do not base any objection or contention upon the verity of the assays; that my objection did not in any way attack the verity of the assay. I did not waive anything. I am perfectly willing to consider the matter with counsel on the other side and see what the stipulation should be to cover that matter, but I waive nothing. I simply said that my objection did not refer to assays, and the first time the word assay was mentioned, was by Mr. Kremer. That is the fact

THE COURT: Of course the court is ruling on matters as they are properly presented, but off the record, I would take it that the stipulation in the Hyde case goes to assays as they were presented, that they could present the result of an assay as from the assayer, but not from the oral statement of some-one else; that is, that both parties would be inclined to accept an assayer's certificate, if he was a disinterested party. I don't know how far these stipulations go, because I have not read them.

MR. SCOTT: I think they are too narrow to cover the present case, and that is why I made this inquiry; but my effort having failed, we will proceed on the assumption of presenting rigid proof.

MR. GARRISON: This is informal, of course, and I don't know exactly what is pending, but I assume that what is pending is your honor's ruling. I want it thoroughly understood that my objection to the test made by Professor Taggart on the 21st of April is much broader than whether or not his basic information was hearsay. I do not wish any misunderstanding in respect to that, and I do not want counsel to say that they are surprised when I urge much broader and deeper and more radical objections than the one that is based upon hearsay. I endeavored to state that it seemed to me that those experiments do not come within any recognized principle of evidence; they are self-serving declarations made up by the defendant; that they are not performed under any conditions which enable us to verify their accuracy or their force; that the only proof which is relevant here is with re-

spect to the prior art, and that this does not in any way, and can not in any way be said to represent the prior art or any part of it, operations carried on on the 21st day of April, 1917, in machines which were not invented until years after the patent in suit—such things can not by the wildest stretch of counsel's imagination be brought within any part of the prior art, and I shall urge all those objections, in addition to the objections which applied to the specific facts stated as a basis for their testimony.

MR. SCOTT: I don't want to consume unnecessary time, but it is a question of the process and of the verity of the statements in the patent in suit. We claim that we have shown that the patent in suit is an absolute misstatement of the facts, which statement of facts we are entitled to attack in 1915 or 1906 or any time while the patent is in existence.

THE COURT: I have heretofore ruled that I thought experiments, present day experiments, would be proper and admissible for limited purpose. They must have some relation to the prior art, to the condition of things as they were at the time this patent was applied for. How much weight they will be entitled to, or how little will depend upon the conditions under which those experiments have been made. Of course some of them may be such a wide departure from things as they were understood to have been at the time of the application; that they would be entitled to no consideration, and others might approximately more closely and be entitled to more consideration, and some might duplicate—some might assume

to duplicate conditions as they were then at the time that the patent was applied for. But certainly it seems to me that with the accumulation of learning, both from study and from new discoveries, or from mechanical operation, new machinery multiplying operations—it seems to me that if your experiments are to include things of that nature, they would not illustrate very brilliantly the prior art. It is a question of degree, of course.

Take this experiment of the Everson—the Fryer Hill publication. There is a machine which is supposed to give us the Everson operation as described in that publication. It seems to me now, as I said then—of course I am open to argument and open to explanation by counsel—but it would seem to me that one factor entered into that which I do not find in the Everson patent, viz. the agitation, which at least this court originally maintained was a proper part of the invention in suit. I could not find in the Everson patent that agitation should be resorted to; it does say thoroughly mixed, but you must read the context of the patent, read the full expression, to understand what she was aiming to do and what she meant by that expression. About your other experiments the same might be said; it is all a question of degree. Some of these experiments may go over the line of admissibility, that is likely to happen ~~to~~ in any case.

MR. GARRISON: All I was trying to do was to prevent counsel from saying, as the result of this colloquy, that if they brought certain evidence as to the

assays, that the defendants would have met the objection as they understood it, and they did not meet it as I understood it, and I did not want them to be able to claim surprise.

THE COURT: Oh, yes. I understand from the very beginning, as far as these experiments are concerned, that there is standing objection which was interposed at some time at the very beginning, and which both parties will not lose sight of, when the court makes up its decision.

MR. KREMER: So there will be no further misunderstanding, we will apply to the strict letter of proof in this instance, and insofar as the stipulations, if any, in the Hyde case are concerned, we will place a strict construction upon those stipulations, so that counsel will now be advised; and we will demand a strict order of proof, such as is demanded of us, in the presentation of their case, so that they won't say they are surprised.

MR. WILLIAMS: That is to say, the defendant having about finished its case, and the complainant being about to commence its rebuttal testimony, defendant now announces that every stipulation of record is to receive a strict construction, notwithstanding the fact that a great mass of evidence has been let in without that. I do not accept that.

THE COURT: No, no; the court understands, and whenever you have any evidence to offer you can bring it up before the court in connection with these stipulations, and the court will read the stipulations. I

have been very liberal with the plaintiff, but these last experiments are clearly outside the stipulation.

MR. KREMER: What we desire to avoid, if your honor please—I don't want the court to misunderstand—any stipulation we have made we will abide by, but that we want to make an offer of proof and we can not do that without the presence of the witnesses.

I can't make an offer of proof by somebody who is not on the stand, and we are going to have the witnesses here present upon the stand in order that we might make a legal offer. Well, I am not addressing myself to the ruling of the court; the court has ruled and I don't care to comment or discuss that at all; that is past; but as a result of that objection, this condition is made necessary by reason of that objection, demanding the strict letter of proof. There is nothing that we can do under those conditions, except to meet the demand, as your honor will readily understand.

MR. GARRISON: I am not demanding anything.

MR. KREMER: You demand evidence as to assays which is the same as demanding the evidence of the men who held the samples.

MR. WILLIAMS: We draw a distinction between assays of regular operations of the mill and experiments.

MR. KREMER: I think we understand each other.

MR. SCOTT: I want to know if this is an objection because this is an experimental operation, as distinguished from the regular mill operation. I don't

think the court based its ruling on any such objection as that. I think the court based its ruling on a question of evidence, and not upon this vague objection that this was an operation out of the usual run of the mill operations; if that is the objection that counsel made or that the ruling was upon, I think they should say so here and now, so that the court should rule upon that objection, which I do not conceive the court has ruled upon at all, except in certain instances where similar objections were made—not identical—the court has overruled them.

THE COURT: Have you heretofore offered experiments like these?

MR. SCOTT: Obviously we have had experiments by Mr. Conrads as I remember at the Magna plant, Mr. Thomas Janney at the Arthur plant, in which they used amounts of oil far out of the ordinary, up to 100 pounds per ton and there has been a general objection, it seems to me, on all of this testimony on the ground that we were estopped from trying the case at all.

THE COURT: Under stipulation as to regular operations, I think.

MR. SCOTT: But these were not regular operations in the sense that counsel has stated the matter this morning, that this is not a regular operation, having this large amount of oil as the court so held.

THE COURT: That is what I say, this one, but the others perhaps went in under this latter.

MR. SCOTT: What I want to get is whether the objection he now is making is upon the ground that this

is an experimental and not a regular operation or whether that operation is limited to the proof.

THE COURT: The court has ruled on the proposition, simply it is one of hearsay. I have not ruled that these experiments were not admissible, but I have pointed out to you all along throughout the record that they may be entitled to very little weight. I cannot sit here and wait while you try and experiment below Salt Lake, and then for them to go down and check that up and see if they can verify it or anything of that sort. I do not think they ought to be put to that trouble, or that the court ought to sit here and wait for them. You have the utmost freedom with all of your experiments in court, as far as that goes.

MR. SCOTT: The offer was simply to check up the experiment. Counsel has ruled upon this question, as it has very properly upon the question of evidence produced, that the proof must be more complete. Counsel still say that that is not their objection, but they do not say what their objection is, and give the court an opportunity to rule on it, or give us an opportunity to meet it.

THE COURT: They too have objected that these experiments under present day conditions are inadmissible, and I think the court has rather persistently ruled against them. I believe if there are other experiments taken away from Butte in evidence—I don't believe they were specially objected to upon that ground. Of course they may have been.

MR. SCOTT: I think with this understanding that we will proceed. I don't recollect whether Mr. Engleman completed everything you wanted of him.

MR. WILLIAMS: Mr. Engleman put in evidence a statement which filled certain gaps in his statement and the only question I would present to him appears on the face of it. You may go on with the next witness.

DR. SAMUEL P. SADTLER, Recalled, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 164. I think when you were on the stand before you referred to a certain work describing what was called the cataract machine, and counsel for the plaintiff asked that you supply an additional page of that work. Is this the additional page which was called for?

A. I have here a number of copies of the page just preceding the page containing the illustration, and that was desired because the description of the experiment, or rather the description of the form of apparatus began on that preceding page so that with the page already offered and this page we have the complete story of this apparatus.

Q. 165. I wish you would state the title of the book from which this exhibit which was admitted as exhibit 50 was taken. Just state the name of it and when and where published and the title?

A. The book is entitled "The drying oils, their properties, compositions and changes, a hand book for

Samuel P. Sadtler

lacquer, varnish and color manufacturers, and so forth, by Louis Edgar Andes." Published in Germany, Braunschweig, in 1882.

Q. 166. In your previous testimony, doctor, when you translated the pertinent part of this extra page —the complete translation with the part that is on this page and the other part on the other page with the illustration, was trans~~mitted~~ lated and entered into the record.

MR. SCOTT: Now, if counsel can consent we will have this added to the exhibit without the formality of offering and further complicating the number of exhibits.

MR. WILLIAMS: This is consented to.

Q. 167. MR. SCOTT: I think when you were on the stand before you referred to several mechanisms described and illustrated in Ure's Dictionary of Arts, manufactures and mines, published in 1860?

A. Yes, sir.

Q. 168. I hand you photographic prints and ask you if those are photographs of the pages of that work that you refer to?

A. I have had photographed the title page and pages 331, 332, 335, 356, and 357, containing illustrations and descriptions of several forms of spitzkastens, and one form of agitating apparatus, involving aeration, when rapidly used, and these are photographs of these pages which were referred to in my previous testimony.

MR. SCOTT: I offer the photographic copies from

Ure's Dictionary, referred to by the witness, and ask counsel if it will be stipulated that these are copies of the pages referred to?

MR. WILLIAMS: It is so stipulated, subject to possible correction on further examination, but I guess not any.

Pages admitted in evidence and marked DEFENDANT'S EXHIBIT 215.

Q. 169. MR. SCOTT: Were you present in court, Dr. Sadtler, when Mr. Dosenbach performed two experiments illustrative of the Everson patent, one in the Fryer Hill machine and one in the cataract machine?

A. I was.

Q. 170. I am assuming that you will be unable to remember all of the facts and details and I will refer you to the description of the details as given by him in the typewritten transcript and ask you to compare what he did with what is described in the Everson patent. (Page 1212 of the statement of facts.)

A. This was an ore which was crushed to 40 mesh, as stated here and a portion of this ore having been taken and another portion given to representatives of the plaintiff. 51 gms. of oil were taken, these 51 gms. of oil, taking into account the specific gravity of the oil, figures out exactly 17 per cent of oil relative to the ore, which was the proportion cited by Everson in her description of the operation using paraffin oil. In that particular case an oil of a certain gravity was taken and a calculation readily allowed the ascertain-

P. 3603, L. 14, insert " a sample of the concentrate was obtained—that having been done." after " done,"

Samuel P. Sadtler

ing of the relative weight of that oil per unit of ore. Therefore, it was 17 per cent. 1250 c.c. of water having a temperature of 42° C. were used. 2.4 c.c. of sulphuric acid added to 50 c.c. of hot water were added after the machine was started. The rotation was between 1400 and 1500 revolutions per minute, as experimentally tested. After rotating the revolving blades there was obtained a mineral froth of the copper sulphide mineral and air bubbles, and this amounted to something over an inch in thickness, from an inch to an inch and a quarter. The difference in appearance between this froth, in color, and the tailings was quite noticeable. That having been done, the Fryer Hill publication was followed still farther in that the semicircular doors which previously had been hanging down during the time of the rotation, acting thereby as baffles during the rotation and assisting in the entraining of air, these semicircular doors were raised so that they came up just under the layer of the floating froth. I examined them at the time and noticed the position of the doors and they were in position after being raised and the froth collected upon them. Then by lowering the jar with its contents, that is the liquid under the froth, it was possible to hang or to leave these doors supporting the froth and separated in that way from the other portions of the liquid. In the Fryer Hill publication we have the description of these parts of the drawing and it states that the water will drain through the fine openings in these semi-circular doors leaving the floating mineral

upon them. Samples were taken of that concentrate by washing the material off of these supporting doors, after having removed the other portion of the liquid below. I consider that this was a carrying out of the Everson process in principle. I consider it was a very careful following of the Fryer Hill description also in which a form of apparatus was described which had been utilized for the illustration of the Everson process.

Q. 171. Referring to the Everson patent and particularly to the procedure as defined in the paragraph beginning at line 93, page 2 of the patent, page 608 of the Hyde record, I would ask you what, if any, directions you have for such agitation of the mass of pulp and oil as took place in the Fryer Hill machine?

A. "In the use of petroleum, or a liquid constituent thereof, like paraffin oil, the condition of the concentrated mass is more liquid than when a vegetable or an animal oil or a fatty constituent thereof is used, and a somewhat different means or method should be employed for removing the sand. In practice, the concentrate, after thorough agitation of the mass and detachment of the sand, will in this case be perfectly removed by means of a constant overflow of water, from a washing out vessel, by which overflow the concentrate will be floated off." We have there of course the thorough agitation as the first step, the detachment of the sand is the second step and the removal of the concentrate as the third step. This is all illustrated in this procedure using the Fryer Hill form of apparatus.

Samuel P. Sadtler

Q. 172. Now, doctor, will you turn for a minute to the patent in suit, No. 835,120, and tell us what language you find there regarding the character and degree of agitation.

A. In the patent in suit we have the statement with regard to agitation as follows, on page 1, beginning with line 82: "The mixture is warmed say to 30° or 40° C., and is briskly agitated in a cone mixer or the like as in the process previously cited, for about two and a half to ten minutes, until the oleic acid has been brought into efficient contact with all the mineral particles in the pulp." Then we have a description of what results from that agitation.

Q. 173. What was that process previously cited that is referred to in the passage you have just quoted?

A. I assume that it refers to the Cattermole processes which were cited in the earlier parts of this same patent.

Q. 174. Can you state whether any especially violent agitation was a characteristic of the Cattermole process.

A. It was.

Q. 175. Now, did you see the second experiment performed by Mr. Dosenbach as representing the procedure of the Everson patent in which experiment he used what was called the cataract machine described in the German book by Andes?

A. Yes, I also witnessed that.

Q. 176. I will refer you to the transcript for the details.

Samuel P. Sadtler

A. Found on page 1217 of the transcript. 300 gms. of Utah Copper retreatment classifier overflow, containing approximately 7.9 per cent copper, 5.36 per cent iron and 77 per cent insoluble, was taken as the ore. To this ore was added 51 gms. of petroleum distillate. This was also calculated to make 17 per cent of oil reckoned on the ore, and it was thereafter mixed until a homogeneous mass was formed. This mixture, following the Everson process, was made before the thinning out of the pulp with water. This oiled ore was placed into the cylinder of the machine and 1250 c.c. of water added at a temperature of 40° C. The machine was then started up and 2.4 c. c. sulphuric acid, and 50 c.c. of hot water was added, and the agitation continued for a period of two and one-half minutes. Upon stopping agitation a mineral froth formed above the semi-circular doors—that "above the doors" was not necessary there—being about one and one-eighth inches in thickness. After allowing the gangue material or tailings to settle to the bottom of the cylinder so that the solution was comparatively clear between the froth and the gangue—

MR. SCOTT: You are reading the wrong description.

A. I read the description that followed after that.

MR. SCOTT: The ingredients are the same but the apparatus was different. I will find it for you.

MR. WILLIAMS: What you have just read is the alleged Fryer Hill experiment.

A. The semi-circular doors identify that.

Samuel P. Sadtler

MR. SCOTT: Page 1218 I think it begins.

A. That is just what I was reading, 1218. The description of the apparatus begins on page 1220 and continues on page 1221. The oil and the ore were thoroughly mixed as before. And the description of the apparatus in detail is on page 1223. In the experiment just completed, following out the Everson patent in the so-called ~~Gattermole~~ Cataract machine—that is 1223—"I used 200 gms. of Utah copper retreatment classifier overflow containing about 6.18 per cent copper, 6.69 per cent iron, and 76.2 per cent insoluble. I added to this 200 gms. of ore, 34 gms. of Texas petroleum distillate and thoroughly mixed the two to form a homogeneous mass." That 34 gms. is again 17 per cent on the ore taken. "I thoroughly mixed the two to form a homogeneous mass." The mixture was made as in the other case before thinning out with water. "Having placed this oiled ore into the machine, I added 1250 c.c. of water at a temperature of 30° C. I next started the machine and directly after starting the agitator I added 50 c.c. of hot water containing 1.6 c.c. of concentrated sulphuric acid. The agitation was continued for two minutes and a half at about 1720 revolutions per minute. The result upon stopping the agitator was that a very highly mineralized froth appeared on the surface of the pulp." The sample was removed and furnished to the complainants for examination. I witnessed that operation and noticed the appearance of the froth at the time.

Q. 177. And what was the result of your observation of the froth and the experiment generally?

A. It was a very dark, mineralized froth, and as stated was approximately one and one-quarter inches or more in height, being rather more than in the preceding experiment with the Fryer Hill apparatus.

Q. 178. With the exception of the difference in the apparatus, did you notice any other differences in the procedure and in the ingredients used between this cataract machine described and the one in the Fryer Hill machine?

A. There was no difference in the principle. There was a difference in the amount of ore that was used and a difference in the amount of oil used. The ratio was precisely 17 per cent oil to the amount of ore taken. It was the same ore in the two cases and the agitation had the same effect, in the cataract machine as it had in the other form of apparatus, in the entraining of air and the result of that in turn was the formation and—formation of an aerated froth which was highly mineralized, which it showed on coming to rest.

Q. 179. Are you familiar, doctor, with the Froment Italian and British patents?

A. I have read them carefully.

Q. 180. Will you explain the process set forth, especially with regard to the Froment Italian patent.

THE COURT: Any difference.

MR. SCOTT: Just slight difference which the doctor will refer to.

A. The Froment Italian patent I will first notice.

Q. 181. THE COURT: These are in the Hyde suit?

P. 3608, L. 17, insert " with the semi-circular doors, the agitation resulting " after " apparatus "

Samuel P. Sadtler

MR. SCOTT: This is the Hyde case, yes.

THE COURT: Proceed.

A. The Froment Italian patent has as its title in the translation which I give it, "A Process for Enriching the Sulphide Ores of Copper, Lead, and Blend by gases combined with fatty bodies." This differs very slightly from the English translation which was submitted in the Miami record.

Q. 182. In the Hyde record?

A. In the Hyde record also previously. I think the translation I gave it is a little better because it does not say "Sulphide and copper ores" in the original French, but it says, "The Sulphide Ores of Copper" because the word "'sulphures" there is used as an adjective and it is the sulphide ores of copper. Therefore, I prefer the translation as given: "A process for enriching the sulphide ores of copper, lead and blend by gases combined with fatty bodies." There is no word in this title, the original French of the Italian patent, or in the English translation which was given in the Hyde record, there is no word offered of its being a modification of any previously known oil process of ore concentration. That does not appear at all in the Italian patent. I will refer to that again. Now, we take up next in the Italian patent the phenomena. Mr. Froment says: "The following phenomena studied by the inventor have served as the basis of the patent, which forms the subject of this invention." These phenomena are four in number and as stated I would like to read them consecutively so that we can consider

them together: "First, when the natural sulphides reduced to fine powder are moistened by a fatty substance they have a tendency to unite in spherules and to float upon the surface of the water.

"2. This tendency is simply retarded by the specific weight, and opposed by the gangue which imprisons the moistened sulphides in its pulverulent mass.

"3. If a gas of any kind is generated in the mass, the bubles of this gas become covered with an envelope of sulphides and thus rise readily to the surface of the liquid where they form a kind of metallic magma.

"4. The formation of these metallic spherules is singularly active if the gas is in a nascent state."

Now, these are the four phenomena stated together as a basis of the Froment invention. This represented his invention which he considered to have been original. It seems to me that to understand Froment's discovery these phenomena must be considered as connected and not analyzed singly, as only thus can we arrive at an understanding of his meaning—a proper understanding of his meaning. For instance, the reference to "spherules" in the first paragraph cannot be understood until after we have read the third paragraph when this very expressive term becomes understood. In previous discussion of this matter it has been attempted at times to give two entirely different meanings to the word "spherules," contending that it meant one thing in one paragraph and another thing in another paragraph. I think I can show that is not a proper interpretation of Froment's meaning. The

mere moistening of the fine powdered ore with a fatty substance could have no effect to produce spherules that would float on the surface of the water whether we add much or little fatty oil. We would get the pasty mass of Haynes or the first Everson example, and the addition of water to this while allowing for the washing out of the gangue would not cause the production of spherules that would float upon the surface of the water. If there was an occasional little appearance of oil in the water this would not be properly described as "spherules" in the meaning as given here. If, however, we read the statement of the third paragraph and remember what is said in the first paragraph about the spherules floating upon the wtaer, the phenomena are readily intelligible. The generation of gas in a mixture of ore, oil and water under the conditions given, and immediately after in his example also will have the result described in the third paragraph, namely: "The bubbles of this gas become covered with an envelope of sulphides and thus rise readily to the surface of the liquid where they form a kind of metallic magma." We can now understand the fourth paragraph immediately following: "The formation of these metallic spherules is singularly active if the gas is in a nascent state." If, "spherules" were to be taken apart and considered as formed under the conditions mentioned simply as there in the first paragraph, we couldn't have any meaning to this fourth paragraph. The meaning of the fourth paragraph is only possible when we have the full connection with several

phenomena, the mixing of the sulphide ore with the fatty substance, the generation of the gas in this mass and then the presence of water so that we shall have a liquid in which something can rise, and then we have stated that "the bubbles of gas, covered with an envelope of sulphides rise to the surface of the liquid," where they form a kind of metallic magma." Now, on the top of the next page in this Froment Italian patent we have still more light thrown upon this matter. We have this statement:

"Accordingly the rapidity of the formation of the spherules and their ascension is in direct ratio to the quantity of gas produced in a given time."

Q. 183. Just where is that, doctor?

A. I think it immediately follows, just before example 1.

MR. WILLIAMS: The latter part of page 910 of the Hyde record.

Just before example 1. There we have so clearly expressed the condition of the formation of the spherules to be dependent upon the generation of the gas and the greater or less rapidity with which they will rise are based upon that, that it is utterly ridiculous to talk about two kinds of spherules referred to by Froment. The spherules referred to by Froment are only a development after gas has been generated. Now, we come to the third paragraph, especially to this phenomenon again of the magma. What is it that is there stated to form a kind of metallic magma? The answer to that is: the bubbles of gas covered

Samuel P. Sadtler

with an envelop of sulphides which rise to the surface of the liquid. These bubbles of sulphide-coated gas are obviously referred to in the fourth paragraph, where their formation when the gas is in the nascent state is spoken of, and they are called metallic spherules, from their round form as they show in the coherent froth or magma. This clear meaning is, however, confirmed in the illustrative example which is given immediately following. We have the statement: "The metallic spherules, pressed one against the other, will become grouped in a magma, clearly separated from the remainder of the liquid."

THE WITNESS: In illustrating the example we have there the statement "the metallic spherules pressed one against the other, will become grouped in a magma clearly separated from the remainder of the liquid." Now, we have the definition of magma in Froment's own language, "The metallic spherules, pressed one against the other," and we are very familiar with that appearance by looking at these mineral-coated froths, looking down at them from on top —"and the magma clearly separated from the remainder of the liquid." This is what Froment meant by a magma, clearly expressed in his own words and defined for us, no matter what other definitions have been found for the term in metallurgical usage or in smelting practice.

Of course it is entirely possible to find many illustrations of magma, and the word magma has been used in a great many connections and in a great many

lines of practice, but we are tied up here by Froment's own explanation and description of what he means. It is the predecessor of the fixed, coherent, armor-coated froth of the patent in suit. It looks like it, and is similarly constituted, and is produced by the same steps, namely the agitation of a sulphide—containing ore with oil and sufficient excess of water to entrain air, and thus cause the formation of air bubbles which, as Froment says in the third paragraph—I should say gas bubbles, because it must be made broader than air bubbles—"gives rise to the formation of gas bubbles" which Froment says become covered with an envelope of sulphides and rise rapidly to the surface of the liquid, where they form a kind of metallic magma. The result is the same froth whether we take it as a number of "metallic spherules pressed one against the other," using what he has called or considered as grouped, into "a magma clearly separated from the remainder of the liquid," or whether we talk about "coherent, armor-coated froth."

Now, these are my conclusions, reached after a very careful study of Froment's language, analyzing every word of it and trying at the same time to bring the several parts of his description together, and they also are based upon my observation of a great many highly coated froths which have been produced in numerous experiments here, and I would like particularly to call attention to this description of Froment, in connection with the pictures and photographs which have been put in evidence, particularly if we look only at the photo-

graph in which the picture is taken looking downward. The appearance of the armor-coated froth is absolutely the appearance of the "metallic spherules pressed closely together and forming a magma," as described by Froment.

I would also like to say that this description of Froment's, of his mass of metallic spherules forming a magma, and the appearance of the metallic-coated froths as seen in the photograph, exactly illustrates the definition of the froth which was given in this testimony by Professor Bancroft. Professor Bancroft's definition of a froth—and it is of record—was as follows: "Froth is a closely packed mass of bubbles having a honey-comb or cellular structure, the walls of the cells being liquid films, and the individual cells containing air or other gases." That is broad enough to include air and other gases or mixtures. And then add to that definition of a froth the result which ensues when we have the froth generated in the presence of an oil, and the selective action whereby the mineral sulphides concentrate in the film inclosing the bubbles.

Then we pass from the froth, as a broad expression, to the special mineral-charged froth of the patent in suit, and of these other illustrations which we have considered. I have also in my previous testimony referred to the language of the two patents of 1910, taken out by Theodore Jesse Hoover and Minerals Separation Limited in one case, and by Edward H. Nutter and Minerals Separation in another case, in which they cite, the English patent No. 12778 of 1902,

Samuel P. Sadtler

which is the English patent of Froment, and in which English patent these descriptions and these statements of the phenomena, and this description of the metallic spherules and of the magma, is exactly the same as it is in this Italian patent, translated. They refer to the result of the Froment patent as showing the process of carrying oiled particles to the surface, and they bracket this British Froment patent with the English patent corresponding to the United States patent No. 835120, as being descriptions of well-known flotation processes.

I had another reference here, but I can't find it.

I now pass to the features of the Froment process as shown in the example which immediately follows the statement of the four phenomena. We have, following that statement of the phenomena an example of an experiment in a test tube, and I will take that up.

First, the components of his mixture, he states here are ten grams of sulphide copper ore with its gangue, 1 gram of limestone, reduced to powder, and 30 drops of water, and a few drops of sulphuric acid, and a thin layer of ordinary oil. In this mixture as thus stated, the ten grams of powdered ore furnish us the sulphide particles and gangue which as a result of the process are to be separated. The one gram of limestone is to react with the sulphuric acid and thus to generate carbonic acid gas, which furnishes a part of the bubble by the gas, which is the basis for the rising spherules referred to in the last paragraph of the example. The 30 grams of water give us the floating

P. 3616, L. 8, insert " in the form of a froth or especially as a gaseous froth," after " surface,"

Samuel P. Sadtler

pulp, and is the liquid on the surface of which the metallic spherules that are grouped in a magma clearly separated from the remainder of the liquid are supposed to float, and the few drops of sulphuric acid liberate some carbonic acid gas. The few drops of sulphuric acid—we might take two or three—being insufficient to decompose the whole of the one gram of limestone contained.

In that connection, a calculation can be made as to how much of the limestone would be decomposed by the few drops of sulphuric acid. Dr. Chandler has stated in the Hyde record, volume 2, page 647, that 1 c.c. of sulphuric acid amounts to from 26 to 32 drops, and other experiments have been carried out and have given the statement that 40 drops constitute 1 c.c. Being very liberal with that, and taking the figure of Dr. Chandler, we can readily calculate how much that 2 drops of sulphuric acid will furnish, therefore, in weight; of course, knowing the weight of 1 c.c. of sulphuric acid—the sulphuric acid referred to is the strong sulphuric acid, and 1 c.c. of that weighs 1.84 grams, because that is the specific gravity of strong sulphuric acid, ~~and 1 c.c. of that weighs 1.84 grams, because that is the specific gravity of strong sulphuric acid~~. Therefore, if we take 2 drops, we would have perhaps only 1/15 or 1/20 of that 1.84 grams, as the active sulphuric acid which is to decompose the limestone. Now, pursuing the calculation, 1 c.c. of sulphuric acid, weighing 1.84 grams, in decomposing limestone will produce .8 of a gram of carbon dioxide,

Samuel P. Sadtler

which amounts to .4 of a litre. Those figures can be found in Dr. Liebmann's testimony—that is, the calculation may be found in Dr. Liebmann's testimony; I can not give you the page for the moment, but I will give it later. Dr. Liebmann has given us that calculation exactly, that 1 c.c. of sulphuric acid produces .8 of a gram of carbon dioxide, amounting to .4 of a litre. Now, 2 drops thereof, the 1/15 or 1/20, according as we regard the number of drops, to the cubic centimeter of sulphuric acid, would produce, therefore, about .04 of a gram of carbon dioxide, which would be .02 of a litre, or 20 c.c. of carbon dioxide, which would be produced—and I will be liberal with that and make it 30 c.c. of carbon dioxide which would be produced by using 2 drops of sulphuric acid, acting upon 1 gram of limestone present in this mixture of Froment. Therefore we get a partial decomposition, with a possibility, using the larger figure, of 30 c.c. of carbonic acid gas liberated in this test tube experiment, which is here described by Froment.

The remaining element of the mixture is the oil. The words used by Froment are, "or a thin layer of ordinary oil." This does not state the amount by weight or measure, and does not give a definite description of the kind or amount of oil, but we can make a guess at how much he meant and what was the character of the oil. First, what did Froment mean by an ordinary oil? Fortunately, he tells us in this same Italian patent which we are considering, in the claim in the Italian patent, according to his expression, "com-

Samuel P. Sadtler

bined with an oily fat body, and not with with an oily body derived from bitumens, tar, naptha, etc." This is perfectly clear as a definition. He does not use petroleum or any derivative of it, or any residuum of petroleum, nor tar nor any residuum or residual of tar. What he did use was a so-called fatty oil, or it is sometimes called, to distinguish it from the essential oil or volatile oils, a fixed oil. However, Froment goes still further in making his meaning definite. In the original French used in the Italian patent he says, "un corps gras oleifiant," which, literally translated, would be a fatty body of the oleifine type. What this means is known to every chemist. The term olefine is taken from the well-known olefiant gas, (or oil-forming gas), known also to chemists as ethylene gas. The name olefine, or as it is in French, "olefiant," is now applied to all the derivatives of this olefiant gas, and in this series we have for example the fatty body olein, and the free fatty acid, oleic acid, obtained from the decomposition of olein. On the other hand we have stearin, and a fatty acid, stearic acid derived from it which do not belong to this olefine series.

Now, of this class of oils we have a typical example in the vegetable kingdom of an olein, viz., olive oil. This exactly fills this description of a fatty body of the olein type, and at the same time it is the ordinary oil of Italy, in daily use as food, and sometimes as an illuminant. I am satisfied that in view of the limitations imposed in the claims of this patent, that wherever in the Italian patent ordinary oil is referred to he

Samuel P. Sadtler

meant olive oil. It certainly could not mean petroleum residuum, as that is absolutely excluded by the wording of the patent claim.

I want to go still further on that exclusion of petroleum. If you take the original French of the claim, he has three words, ("Bitumes, goudron, napthe, etc.)" and which have been translated, bitumen, tar and naphtha. It is in regard to the last that I want to say a word. The word naphtha is generally applied now to a fraction of petroleum, but in the past it was not so applied either in this country or abroad. When the oil development first began in Western Pennsylvania in 1859, the oil occurrences were always referred to as naptha springs, and the crude product was referred to as naptha. That is not, at the present time observed as a designation in the English language, and to illustrate that, I will read from Bacon's "American Petroleum Industry," which is a new and very complete book just published, and in the rear of this book we have a glossary of terms with the meanings, and I take the word naphtha, and I find as follows, in regard to it: "This term, which was formerly applied to any fluid, and volatile, variety of bitumen, is now generally applied merely to those petroleum fractions which boil below 280° F." That is, in American usage, it is no longer applied to a crude oil, but is applied specifically now to this light fraction; but in the foreign usage it is still applied to crude petroleum, and I have here a French technological dictionary, the title of which is "Tolhausen Dictionaire Technologique." This is a

Samuel P. Sadtler

splendid work, which I have known for years, and in this volume we have the French word first, and then the German and then the English, and if I turn to the word "naphthe," which is found in the French patent, we find as a synonym for that, "huile de Petrole," or petroleum oil, or simply petrole. Then, as the German equivalent of the word napthe, "erd-oel, Stein oel," and as the English equivalent, naphtha, rock-oil, petroleum.

I really believe, therefore, that we are perfectly justified in translating Froment's French language in an accurate way, and if we translate it in an accurate way we will see that that portion of the sentence inclosed in the brackets absolutely shows that, not only bitumens of all kinds, tar of all kinds, but also petroleums are named; and if we take with that the other showing in the claim of the patent, that he particularly prescribed a fatty body of olefine type, I think Froment has limited the kind of oil very distinctly for our benefit.

Now, we come to the quantity of oil. As before said the expression "a thin layer of oil" is not very definite. Dr. Liebmann, in the Miami case, in testifying stated that using olive oil, he found the amount necessary for a thin layer amounted to 12.5 to 15%, reckoned on the weight of the ore. If we take 10 grams, this would amount to 1.25 grams, or 1.5 grams respectively, of oil.

There is other testimony on this matter, however, in the Hyde record, volume 2, page 308, where William Henry Ballantyne, who testified, said as follows: "I frequently tried the Froment process in a test tube,

Samuel P. Sadtler

and I found that a thin layer of oil amounts to not less than about 5% of the weight of the ore." I made a number of tests of my own to get a thin layer of oil, using olive oil, and I found that, according to the temperature of the water mixture, I was able to get a layer of oil which not only was relatively a distinct layer—more than a thin layer, looked at from the side—but I took it that the point which ought to decide the matter as to a layer of oil was looking at it from above, in regard to touching the circumference of the glass or test tube, and getting a layer of oil which completely touched the glass all around the edge, I was able to get a layer with a little less than 1 c.c. of olive oil when I used the lowest temperature, which was 25° C., and when I used a temperature of about 40° C., which is not very warm, I found that about .3 of a c.c. of olive oil completely touched the sides of the glass test tube, and therefore made a layer of oil which was a complete layer covering the whole of the water underneath. Therefore I assume that 1 c.c. of olive oil would be quite sufficient, even with a lower temperature, to answer the description of Froment as to the amount necessary to be used to form a thin layer of oil. Now, with the specific gravity of olive oil, which is about .09, that would give us 9%, reckoned on the weight of the ore; so I would be satisfied to call it 9%, which is rather less than was stated by Dr. Liebmann, and is rather more than was stated by Mr. Ballantyne, and 9% is quite sufficient to illustrate the experiment with.

We go now to the consideration of the steps of agi-

Samuel P. Sadtler

tation. This is referred to in the Froment Italian patent in the test tube example and says "and the mixture then agitated for a second." The English patent, referring to the step, says "then agitated for a brief space."

Under these circumstances we may assume that the "second" is not to be measured to the minute fraction, but is an approximate measure for a brief agitation. I take it that the words "agitation for a second" is a figure of speech, meaning a very brief agitation.

As the experiment given by Froment in his example is carried out in a test tube, the agitation is most readily effective by closing the test tube containing the mixture with the thumb and shaking it momentarily, approximately a second or two. Now, the results.

The result of this agitation I find as it is stated to be, that the copper pyrite, that is, the metallic mineral, will instantly rise to the top of the liquid. That is the expression "will instantly rise to the top of the liquid."

Now, the appearance of this mineral which thus rises through the liquid to the top is then stated. It is not sufficient for us to understand that the copper pyrite rises to the top of the liquid; its appearance, and conditions by which it exists at the top of the liquid are clearly stated. "The metallic spherules, pressed against one another, will become grouped in a magma, clearly separated from the remainder of the liquid," and then of course the production of the gaseous froth, as a result of agitation. This froth, the gaseous froth produced, is unquestionably produced directly by the

Samuel P. Sadtler

agitation; the agitation is the direct cause of its production.

A further statement of the result which follows immediately after is, that the small quantity of gangue, mechanically entrapped, gradually falls from the sulphides and the sulphides remain in a state of almost complete purity. Such is the principle.

Now, we have in this section, which gives an example of the working of the test tube experiment, a caution to the inexperienced in chemical manipulation; Froment says, "if the limestone is in excess, or readily attackable, the rapidity of the separation is so great that the copper pyrite is forcibly ejected from the vessel. Therefore, a correct proportion has to be given for a given ore and a given limestone." Now, it seems to me that that, taken together with the mention of the proportions and of the amounts of the different ingredients, is all that is necessary to enable one to entirely avoid a good deal of what looks to be to be simply illustrative of inexperienced manipulation.

That a test tube should be shaken and the whole of the contents thrown violently out and over against the wall is not a necessary result if we pay attention to what Froment has stated. It might happen occasionally, but I am satisfied that, if we take the statements made here, the decomposition of the limestone is going to be such as to instantly throw out the contents of the test tube.

In some of the previous experiments that I have read in connection with the testimony in this action,

Samuel P. Sadtler

illustrating Froment, the amount of acid was distinctly taken fully equal to the amount of limestone. Froment does not indicate what that would do, or that we should take 1 gram of limestone and 1 gram of sulphuric acid. If he had meant to say so, he would have said so, and therefore, if we take his language and make our translation accurate, we can see what the minimum decomposition of the limestone would be, which limestone is here 10% of the ore. That amount is absolutely unnecessary, and it is not contemplated except as an accident, and as to the accident, of course, he has given a caution.

There is one other statement that we need to notice before going on to the claims of the patent; in connection with example No. 2 of Froment's Italian patent, which comes just before the claim. The statement is as follows: "There are several distinct but connected operations in the practical working of the process; the formation of the spherules and their separation from the gangue, then separation of the concentrate and the oil, and recovery of this latter for a re-entrance into the circuit of operations. The products of the concentration form oil cakes." The English patent simply says, "form cakes." I simply conclude that Froment at the time thought that there would be a possibility of his pressing his concentrate and recovering the oil. That is another matter, however, and I have not taken that up, because it does not illustrate the principle of the froth formation; the froth formation is entirely irrespective of whether he recovered the oil or did not

Samuel P. Sadtler

recover the oil, and therefore I leave that for what it is worth.

The first of these operations, the formation of the spherules or gas-bubbles coated with a film of oil carrying metallic sulphides, and their separation from the gangue by reason of their rising to the surface of the liquid, where they form a dense metal-coated froth or magma, as Froment has called it, has been discussed already.

The other two relate to the concentrates already existing apart in the froth on the surface of the liquid. How these two latter steps are carried out he does not state here, and for light on this subject or his later development we have to turn to the Froment description, a document which was not published, and is not essential to the understanding of the principle.

I now come to the claim of the patent. I have already referred to it somewhat in speaking of the nature of the oil. However, as it is short, it will be well to give it in full.

"I therefore claim, as being my exclusive and entire property, a process consisting in enriching sulphide and other ores, graphiteous ores and their derivatives, sulphide earths, or others, by means of gases, whichever they may be, combined with a fatty body of the olefine type, and not with an oily body derived from bitumens, tar, petroleum, etc., and whatever may be the apparatus in which the process could be applied."

Before commenting upon this claim, which is very broad, let us compare it with the claim of the corre-

P. 3627, L. 13, insert " the clear intent of certain features of " before " the invention "

sponding English Froment patent, No. 12778, of 1902. The wording there is as follows, found in the Hyde record, page 787.

"The herein described process for the concentration of metalliferous ores and earths, which consists in commingling the finely powdered ore or earth with water, and adding a suitable oil, and then liberating a gas in the mixture, substantially as described and for the purpose specified."

This is condensed, but it is condensed at the expense of clearness of statement, and involves the omission of the invention, viz., the defining of the kind of oil to be used. In several points, also, I consider that the wording of the English patent claim is less explicit; there is, in addition to this matter of the character of the oil—for instance, the Italian claim is for a process to enrich sulphide and other ores, graphiteous ores and their derivatives, sulphide earths, or others." While the English claim is for a process "for the concentration of metalliferous ores and earths," without qualification. It is broader, obviously, but it is less informing and less definite.

(Recess.)

THE WITNESS: I was speaking of the points of difference between the claim of the English patent and the Italian Froment patent. I stated that the English patent claim was distinctly less explicit in several respects. This view is not solely my own, but is shared by Dr. Liebmann, one of the experts who testified on one of the former trials in connection with this process

Samuel P. Sadtler

in Patent 835120, and I find in the Hyde record, Volume 2, page 460, Dr. Liebmann's expression about this same thing as follows: "The Italian specification precedes the English one by a short time, and the English is clearly a translation of the Italian document, with such slight alterations as a translator who is a British patent agent would make. There are some mistakes in the British document, which cloud the true meaning of the original, to which I shall refer later." Dr. Liebmann pointed out also, as I have done, some distinct points of difference. In my mind the most important point of difference by far is the absolute silence in the claim of the English patent as to the character of the oil which Froment desired to use. The term "suitable oil" is utterly inadequate in view of what appears in the Italian patent, in which Froment quite distinctly and specifically limited the kind of oil which he had desired to use.

On the other hand, the English claim indicates the general method of the operation described better than the Italian claim. The English claim, for instance, says: "It consists in mixing the finely powdered ore or earth with water, adding a suitable oil, and then liberating a gas in the mixture, substantially as described and for the purpose specified," while the Italian claim does not give these steps, but merely claims "by the means of gases, whichever they may be, combined, with an oily body of olefiant type." The Italian patent claim therefore does not tell us how the co-operation of the gas and the oil is to be effected;

Samuel P. Sadtler

but while that is wanting in the Italian claim, the information contained in the specification and example of the Italian patent are perfectly adequate to supply that information; the information is quite complete if we take it from the specification, including the phenomena as stated, and the example.

Now, we come to the nature of the gas which forms the spherules in Froment in the example given in his Italian and British patetns. In the Froment Italian and British patents, the test tube examples given quotes 1 gram of limestone to 10 grams of ore and a few drops of sulphuric acid. I have already shown that this amount of sulphuric acid is insufficient to decompose the calcium carbonate of the limestone. The amount mentioned in the patent of 10% of limestone relative to the ore was too much, and that is also intimated by Froment in the same paragraph, where he says "a correct proportion has to be found for a given ore and a given limestone," which shows us that he did not wish to intimate that the reaction required uniformly the same amount of limestone; and later, when he comes to furnish his description, he goes into that subject much more fully, and gives the amount of limestone relative to the amount of ore, which is very much less than is here stated in the example.

In the Froment instructions to which I just referred 1%, or in different cases a maximum of 2% of limestone is stated to be the correct amount, as against the 10% which is to be given in the example. The sulphuric acid added in the second stage of the operation

Samuel P. Sadtler

described in Froment's instruction is calculated to exactly correspond in that case in weight with the calcium carbonate, which is essential to effect the complete decomposition.

Coming back, however, to the test tube experiment of the Froment patent, what is the nature of the gas which inflates the metallic spherules which rise to the surface on agitation?

It has been assumed that it is essentially, if not entirely, carbonic acid gas. I think a little reflection will show that this can not be the case. We start with a test tube containing 10 grams of ore, one gram of limestone, 30 grams of water, a thin layer of oil, and a few drops of sulphuric acid, insufficient in amount to decompose the amount of limestone present. The rest of the open space in the test tube is of course filled with air. We close the test tube and shake up vigorously for a second. The volume of carbonic acid gas liberated, corresponding to the partial decomposition of the limestone by the few drops of sulphuric acid, is small. Remember, now, that under normal atmospheric pressure, one volume of water will retain, dissolved, its own volume of carbonic acid gas, so that it is only the excess over this volume that is free to escape and mix with the air which is being entrained by agitation. The mixed gases which form the froth or magma of metallic spherules, it is plain, must be predominantly air, with a relatively smaller amount of carbonic acid gas, which will inflate the air bubbles, or gas bubbles, we will call them. The mixture of gases, therefore, which form the froth or magma, it is plain,

Samuel P. Sadtler

will be a mixture of carbon dioxide and air, and predominantly air, with a relatively smaller amount of carbonic acid gas.

Dr. Liebmann, a former witness, has testified in the Hyde record on this matter in volume 2 of the Hyde record, page 557, as follows:

"I pressed the lower end of the thumb on the test tube, and shook first for two seconds, what one might call violently. Then I made an observation, and after that shook again for 6 or 8 seconds. The amount of carbonic acid which could have been evolved was so small that it would have been dissolved in the water which was present. It requires over 7 c.c. of water for the solution. From the experimental evidence and from my experience, I have grave doubts whether carbonic acid would evolve at all."

I would not go quite that far. I think carbonic acid is evolved, as far as my experiments in the test tube have shown, but I will agree with Dr. Liebmann that the amount of free carbonic acid gas, which is residual, after the reaction and which can mix with the air already contained in the vacant space in the tube, is small in amount, and therefore the conclusion is readily drawn that we would have a mixture of carbonic acid and air, in which the air is certainly two-thirds or three-quarters of the mixture. That would make it accord with the proportion of the mixtures which have been produced under the processes of the patent in suit when they were operating with ores relatively rich—containing say five to six per cent of calcite. Dr.

Samuel P. Sadtler

Liebmann has testified in that connection as to the analysis of the mixture of gases resulting from the operation with the San Francisco del Oro ores in Wales, where he found as a composition of the gases inflating the froth produced by the operation of the patent in suit, 77½% of air and 22½% of carbon dioxide. I do not believe that if we carry out the test tube experiment of Froment, using the proportions that have here been stated, that we will have as the composition of the gas mixture anything very different from what is there stated to be the composition of the gas mixture inflating the froth produced by the patent in suit. It must be remembered that we also have in the Froment Italian patent the claim, " by means of gases, whichever they may be." And we must remember also that the patent in suit, No. 835120, says, page 1, lines 91 to 94: "A froth or scum which has derived its power of flotation *mainly* from the inclusion of air bubbles introduced into the mass by agitation."

"A froth or scum which has derived its power of flotation—" I didn't quote it correctly before—"A froth or scum which has derived its power of flotation mainly from the inclusion of air bubbles introduced into the mass by agitation." We find, therefore, that a gaseous mixture is possible and is allowable by the language of these two patents, in either the case of the Froment or the patent 835,120. The Froment description which became public later need not be discussed in the same way that we have discussed the two patents in which Froment made known to the world his dis-

Samuel P. Sadtler

covery and clearly enunciated his understanding of the principles therein involved, and made his broad claim. The description, with accompanying drawings shows a two-step process instead of a single step process as given in the example of the patent, Italian and British. We have in the Froment description—

MR. SCOTT: Page 730, volume 3, of the Hyde record, that is the translation of it.

A. 730 of the Hyde record, volume 3; the description with accompanying drawings shows a two-step process instead of the single step process given in the example of the patent. We have a centrifugal mixer for the ore pulp, limestone and oil, in which there is an energetic agitation which, from the construction of the stirring devices, entrains air and forms an aerated froth. The stirring devices are shown there in the dotted lines which are to revolve in "a," centrifugal mixing device, by the revolution of this stirring device we have the same vortex form of motion generated, and the entraining of air with the formation of an aerated froth. This, however, is discharged without being allowed to separate, discharged into a vat with leaden coil for the introduction of sulphuric acid and steam, and with a horizontal rake to be slowly revolved after the introduction of the sulphuric acid, and thus gives a supplementary gas-bubble development for the purpose of raising additional mineral not already in the froth formed at first. The only radical difference is that the sulphuric acid comes into the operation in the

so-called coil vat. In the test tube experiment, it is all done momentarily and in the reaction of the sulphuric acid in the test-tube experiment we of course have an actual reaction of the sulphuric acid on calcite; but the brisk agitation gives us the shaking up of a large volume of air in the test tube with the watery pulp and oil globules and the entraining of the air with the incidental amount of carbon dioxide is accomplished in this way. The accomplishment of the result is rather different in the process described in the Froment description. A Froment machine built upon the description and built to operate as here figured I have seen operated repeatedly and I have seen results obtained from the same which gave an excellent froth, as a result of the first operation, supplemented by a small additional amount of froth by the operation of the sulphuric acid acting on the limestone in the water.

Q. 184. Do you wish to illustrate the Froment patent?

A. I would like to have the test-tube experiment shown. (Test No. 37.)

MR. SCOTT: Do you want a sample, Mr. Williams?

THE WITNESS: This is Butte & Superior ore we are talking about in this case, 10 gms. Butte & Superior ore and 1 gm. calcite.

MR. WILLIAMS: About two-fifths of an ounce, isn't it?

A. I don't think in ounces very quickly. We add 30 c.c. of water.

Samuel P. Sadtler

Q. 185. MR. WILLIAMS: At what temperature?

A. 37° C. 2 drops sulphuric acid and one cubic centimeter of olive oil. 1 c.c. was the full limit that I thought necessary. That makes 9 per cent.

Q. 186. MR. SCOTT: Does the oil form a layer, doctor?

A. It does form a layer.

Q. 187. Over the entire contents?

A. Yes. I verified that before. Now, that is the one second, used as a figure of speech, for the production of froth, which is merely an air froth. There was pressure as can be seen by the fact that it squirted a little bit there. A slight additional agitation will continue the result. (Agitating the test tube again.) We have there now three-quarters of an inch of froth. And that gives us all that was described by Froment, metallic spherules pressed together closely forming a so-called magma which to all intents and purposes, looked at from above, has all the appearance of the froth which had been produced by other modes of agitation. We have there the clear metallic coating, the spherule formation and appearance and everything that has been described. That has become quite pronounced now, it is quite dark. Of course this a zinc ore. With a copper ore the distinction in color is even sharper.

Q. 188. And do you plan an experiment in the Gabbett of the California Journal process?

A. Yes.

Q. 189. We might do that now.

Samuel P. Sadtler

A. An experiment has been arranged for to illustrate the procedure of the California Journal of Technology which was to produce the foam effect by utilizing a form of mechanical agitating apparatus to produce the froth effect, which was quite well known from 1889 on and of course known in 1903 when this article was published in the California Journal of Technology. I refer to the Gabbett cone mixer which was patented in England in 1889 and patented in the United States in 1891, which was 12 years before the appearance of the California Journal of Technology. There is being used here a copper ore. The California Journal of Technology referred to there tells of copper ores as well as the tests with the molybdenite. The quantitative results which were given in that publication refer to molybdenite, but it was also tested with copper ores as stated by them, but not quantitatively. We have 250 gms. of copper ore, chalcopyrite ore.

Q. 190. You might describe the different ingredients.

A. With 250 gms. of this chalcopyrite ore we take 1250 gms. of water at a temperature of 25° C., 13¼ gms. fuel oil, California fuel oil, a paraffin product, which is equivalent to 5.3 per cent relative to the ore. The foam effect was obtained by these students who published this article with varying amounts of oil relative to the ore as low as two and a fraction of a per cent up to nine per cent. 3 c.c. of concentrated sulphuric acid. Sulphuric acid was used by them as well as salt solution in their experiments in producing the

Samuel P. Sadtler

foam effect. The agitation will take place in the Gabbett cone machine, five minutes agitation. All of the elements which are here present in this experiment are justified by the statements made in the California Journal of Technology or by the knowledge which was available at that time.

MR. WILLIAMS: Just note that the temperature of the water was 25° C.

A. I have that; I read it a minute ago. We are endeavoring to get the exact amount of the fuel oil by weighing, by difference in weight, weighing the beaker containing the oil and pouring a certain amount in and then weighing the beaker again and then taking the difference in weight as the amount taken. (Test 38.)

You can see the result of the foam produced after the California publication.

THE COURT: What was the oil?

A. The oil was 6.1 per cent instead of 5.3 per cent, as they added more than they intended to.

MR. WILLIAMS: I think we ought to have the tailings for assay if any assay is made because we cannot see them in this machine and don't know what their color is. If possible, let the tailings be assayed as well as the froth, so as to get some idea of what the operation has accomplished.

MR. KREMER: Do you want a sample of it?

MR. WILLIAMS: Yes.

THE WITNESS: While that is being gotten I would like to say that the California Journal of Technology published in that issue the basis for all three

experiments. Two of them have been standing upon the desk here in sight for a week or more.

Q. 191. Since the day which the record will disclose?

A. Yes. One with a dilute sulphuric acid and the other gotten in a salt solution with an amount of oil corresponding to that stated in the publication and gotten by agitation only in the tall cylinders, and illustrating what was there called the foam effect. In this third experiment we have taken the same ingredients and have gotten the foam effect in the form of a definite froth, which is, however, no more definite than what was shown there by putting—

Q. 192. (Interrupting.) That which is shown in the cylinders?

A. No more than what is shown in the cylinders by applying mechanical agitation instead of the mere shaking, the form of apparatus being one which was quite well known, in fact had been patented in this country 12 years before the publication of the California Journal of Technology paper.

Q. 193. Do you know, doctor, of any other apparatus suitable for that purpose that was also known at the time of the issue of this California Journal of Technology?

A. The Johnson cone mixer was also known.

Q. 194. Can you refer us to anything that shows that in this record of the Hyde record, which is in this case?

THE COURT: It seems to me I saw a churn in the Hyde record too.

MR. SCOTT: Page 966.

A. The Johnston cone mixer, as it is called, is illustrated in the Wolf patent which appears as patent No. 787,814, page 966 of this volume 3 of the Hyde record.

MR. WILLIAMS: Page 966 of complainant's record is the Wolf patent.

A. The Johnston mixer as it is called, which was shown in the Wolf patent was referred to by Mr. Henry L. Sulman in the Hyde record, volume 1, page 274, in answer to cross-question 149 on that page: "You have said that this Johnson mixer was well known at the time of the Wolf patent. I note that the patent was issued on April 6, 1905, upon an application filed in May, 1903. Did you intend to include one or both of those dates in your answer? A. I intended the earlier date. Mr. Sulman testifies that this Johnson mixer was well known in May, 1903. The California Journal of Technology appeared in November, 1903, six months or more after the time at which Mr. Sulman testified the Johnson mixer was also well known. We have there two very efficient mechanical forms of apparatus."

Q. 195. Explain the apparatus while we are on this subject?

A. I would rather refer to that again in my other testimony. I will come back to that.

Q. 196. Just as you please, doctor.

A. I have nothing more to say on the Froment at present.

Q. 197. Then, doctor, suppose we get your idea on the Kirby process, shown in the Kirby patent 809,959.

MR. WILLIAMS: Patent printed on page 738, defendant's record in the Hyde suit.

A. I think next—

MR. SCOTT: Doctor, before you go on, I can't remember whether you commented upon this froth, and told us its appearances and structure?

A. In a general way only.

Q. 198. I would like to have it.

A. The froth produced by this experiment with the Gabbett cone mixer and intended to illustrate the publication (procedure) of the California Journal of Technology, is a very decided mineralized froth possessing the heavy mineral coating which has been seen in similar froths produced by other processes, and I am satisfied from the corresponding experiments made simply by the shaking in the tall cylinders that the froth here obtained will be a very durable froth. It is of course as seen now a distinct separated froth. The liquid below is clearing rapidly and we cannot see the tailing, but I have no doubt but what the distinction will be very sharp between the froth and the tailings; and therefore it is to my mind as complete a separation under the influence of aeration by agitation as is ordinarily accomplished by following the process of the patent in suit.

Q. 199. How would you say that the structure of this froth compared with Professor Bancroft's definition of an agitation froth?

Samuel P. Sadtler

A. I can see quite clearly the appearance of the rounded cells, which of course are filled with air, and the walls of which are of thin layers of oil in which cell walls have concentrated the mineral sulphides, thereby stabilizing the froth, and in every respect corresponding to the description of what a froth is composed of. The peculiar physical appearance of the froth, that is, the pitted structure, and the other characteristics which we become acquainted with by the photographs are also quite noticeable in this froth.

Q. 200. I think you referred to the fact that the authors of this California Journal of Technology described particular experiments in which the quantity of oil ranged from two and a fraction up to eight or so?

A. Nine.

Q. 201. I presume in view of that you do not consider it material that a little over six per cent of oil was used in this experiment instead of 5.3 that I think that you planned to have used.

A. No, the only material feature is we kept within the range which is indicated there in that California publication and it is distinctly above the range which is claimed in the patent in suit.

Q. 202. Now, doctor, after this interruption you may go on?

A. I will turn to the Kirby patent, United States Patent No. 809,959, patented January 16, 1906, application filed December 14, 1903.

We can best understand the Kirby patent, what it means and what it achieves by taking his statement of

Samuel P. Sadtler

steps as given on page 1 of the patent, beginning with line 65: "The process, as an entirety, in its best form for use with Rossland ores for the purpose stated consists in the following steps: First, in thoroughly agitating together (a) the pulverized ore or mineral material; (b) enough water to make with said pulverized ore a flowing pulp, and (c) a solution of bitumen in a thin distillable hydrocarbon liquid as kerosene, these materials to be so thoroughly agitated together as to finely subdivide said solution into small globules and bring said globules into contact with substantially all of the pulverized mineral particles which will, by preference, adhere to them."

THE WITNESS: This is the first step, which they have described, the agitation. Now, we will note with regard to this agitation that Kirby speaks here of thorough agitation. The term "thorough agitation appears twice in this paragraph which has been quoted from his patent specification. In several of his claims, notably in claims 1, 2 and 3, he used the expression "violently agitated," as applying to his first step of the process;—violently agitated. Now, Kirby's agitation or mixing tank is shown in Figure 1. There are four figures attached to this Kirby patent, and in Figure 1 we have shown Kirby's agitation or mixing tank at the extreme upper left hand corner. This agitating device is described on page 3 of his patent, line 100, as follows:

"In the mixing tank a vertical rotating shaft A

Samuel P. Sadtler

is mounted having, preferably, a lower bearing similar to that which is provided for shaft B, and which has been described. Arms A^1 are attached to the shaft near its lower end, and lifting plows are secured to the outer parts of these arms, and radial plows to the other parts thereof, just as in the separator tank. This shaft A is to be rotated rapidly, and the result is a sort of commingling of the various parts of the charge, which result is facilitated by the currents created in the charge by the action of said plows, the direction of said currents being indicated by the arrows in Figure 1.

We have noted there the arrows, and it shows that the liquid is rising near the outer circumference of the tank, and apparently descending along the central shaft on either side. That is a clear diagrammatic illustration of the vortex motion obtained by this machine. The vortex motion is there illustrated by the dotted curved line, illustrating the upper surface of the liquid, which is shown there curving inward to the center. When the rotation is kept up that can be quite easily seen in all these mixing devices, for instance like the Gabbett mixer and many others we have these radial arms rotating. We have here indicated not only the direction of the vortex current by those arrows, but also by the dotted lines in these liquids, showing the same drawing down of the liquid which takes place in the Gabbett cone mixer.

Now, this necessarily involves the drawing in of air with that motion; you also get some entraining of

Samuel P. Sadtler

the air as practiced in the Gabbett mixer described in the first step of the patent in suit.

Kirby tells us practically that shaft A is to be rotated rapidly, and insists in his claims, on violent agitation in connection with this first step. Moreover, I would call attention to the fact that Patent 809959 is for a process, and his illustrations are merely for the purpose of showing the way in which the process can be carried out. This is clearly stated by him in lines 26 to 29 on page 1, as follows:

"In the drawings, Figure 1 is a diagrammatic view of an apparatus with which the process may be practiced, the several parts thereof being shown in vertical section."

At the time of the application for the Kirby patent, two other mixing devices adapted to produce aeration by rapid agitation were well known and available; one of them has been referred to just recently, the Johnson mixer, in patent 787814 to Wolf. Mr. Sulman has testified in regard to this in defendant's record in the Hyde case, page 274, first, that this Johnson mixer was designed to produce much the same effect as the Gabbett cone mixer. I would like to refer to that and verify it. Mr. Sulman testified as follows: "The apparatus was designed to produce much the same effect as the apparatus generally known as the Gabbett or cone mixer. In this instance the radial arms supporting the inner tube acted as efficient baffles, preventing the undue rotation of the liquid as a whole."

Now, that is best understood if we refer to the Wolf patent and see what he meant by radial arms at the sides. In this Wolf patent, the values of the radial arms is there referred to, and Mr. Sulman says in regard to them, that the radial arms supporting the inner tube act as efficient baffles; in other words, the rotating liquid starting to rotate by this rotating device here, is broken constantly by those baffles, or those arms acting as baffles. Mr. Sulman also states, in answer to the next question following, that this Johnson mixer was well known in May, 1903.

The other aerating and agitating apparatus was the Gabbett cone mixer, which was patented in England in January, 1889, and patented in the United States in January, 1891. I have already referred to the fact that both of these dates, the date of the patenting of the Gabbett cone mixer and the date of the knowledge of the Johnson mixer as testified to by Mr. ~~Sullivan~~ Sullman—that both of these dates were prior to the California Journal publication dates.

Now we come to the consideration of the Kirby patent—We come next to the results of this first agitation step. The result of this first thorough or violent agitation is stated in lines 109 to 114 on page 3: "This shaft A is to be rotated rapidly, and the result is a thorough commingling of the various parts of the charge, which result is facilitated by the currents created in the charge by the action of said

plows, the direction of said currents being indicated by the arrows in Figure 1."

As I have just explained, these currents constitute a vortex, which, with the rapid agitation, must involve the entraining of air. The second result, however, is stated by Kirby on page 1, line 79, as follows: "In allowing the hydro-carbon coated particles to float to the surface of the mass, and in rendering this separation substantially complete by gently agitating the mass and by injecting gas into the same, and preferably also discharging into the mass fine streams of the solution. When the separation is completed, the floating hydro-carbon concentrate is removed for subsequent treatment."

The statement of the results that the hydrocarbon-coated particles float to the surface of the mass, means that they are there as a part of a froth on the surface of the air bubbles developed by the entraining of air in the rapid motion followed by the vortex action of the liquid, with the air bubble production.

There is only one conclusion, as I say, to be drawn as to what this float was; this float could only have been an aerated froth, coated with mineral particles. Now, it has been shown experimentally in two experiments already in this case here in court—It was shown by Mr. Phillips in producing the product obtained with 25% kerosene in the small glass jar, the remnants of which are there on your honor's desk, and it was shown by Mr. Dosenbach in a larger glass jar, using the proportions of this kerosene indicated by

Samuel P. Sadtler

Kirby—in other words, these experiments made in connection with this trial have illustrated what I am here describing as the necessary result of the several steps of agitation given by Kirby in his patent.

Now, we get to the second step. The second step is clearly stated to be a secondary, and not a primary part of Kirby's process. In the language of the patent, page 1, lines 81 to 85, after what I read in regard to the floating to the surface of the mass, it says, "And in rendering this separation substantially complete by gently agitating the mass and by injecting gas into the same and preferably also discharging into the mass fine streams of the solution."

Again on page 2, in lines 44 to 48, the same matter is referred to as follows: "The introduction of a gas, preferably air, into the mass, which is the additional novel characteristic of the second step of this process, assists in the flotation of the hydro carbon coated particles." Notice the word "assists".

The character of the second step as a complementary step is clearly illustrated in these two citations; as steps to make more complete the original froth separation, and this secondary process is characteristic of practically all agitation processes, and is very clearly stated in the patent in suit, as desirable.

Kirby says again "the invention consists in the process hereinafter described and in the several steps thereof, all of which will be definitely set forth in the claim." We have a clear recognition of the fact that there is a primary and a secondary step, and the two

may be taken as individual steps, combining to get what he considers to be a more complete rising of the particles and accomplishment of his result.

Again, on page 1, line 95, the matter is referred to. Kirby says, "The use of a gas to assist in the flotation of the coated particles, as set forth in the description of the second step of the process, is radically new in this art, irrespective of its association with the other steps described." There is another statement which appears shortly after that, which I think is a gratuitous statement, not connected with the description of the process, but which sometimes is considered as having a very notable bearing upon the process. I wish to call attention to that:

Kirby's suggestion in line No. 102, that his second step could be used advantageously in connection with the prior processes using thick, viscous oils, to prevent the flouring, has nothing to do with the present invention, and in view of the first step, it can not be. It was evidently a bulk oil process to which he was referring.

As to this view of Kirby's that the use of a gas would be a good thing in connection with the thick viscous oils, that is a supplemental step, and it is not necessary for me to say whether I agree with Kirby as to that or not, because I have not tried that idea, but it has no connection whatever with the clear-cut, two-step process which is described by Kirby, the first step and the second step.

Whereupon further hearing was adjourned until Thursday morning, May 3d, at 10 a. m.

Thursday, May 3rd, 1917, 10:00 A. M.

MR. GARRISON: From evidence recently adduced by the defendant in this suit, we have been convinced that in addition to infringing the patent which is pleaded in this suit, they have also been infringing another patent owned by the same plaintiffs, which we know colloquially as the soluble frothing agents' patent No. 962678 of June 28th, 1910. We purpose filing a bill to protect our interests with respect to that patent but it occurred to us that since Mr. Scott and Mr. Sheridan are thoroughly familiar with all of the issues that can arise under that patent because in their defense of the Miami Copper Company during the nine weeks' trial at Wilmington and the six days in the Court of Appeals at Philadelphia that patent was one of the points in litigation and all of the evidence was minutely gone into and briefed and debated, that they would perhaps prefer to have us bring that patent into this suit and join issues upon the question of our right under that patent in respect of their acts and try that out at this time. If they so elect and are ready to join that issue now and to proceed with this trial, we are willing to adopt that course. Otherwise we shall pursue by an independent bill the right which we have to litigate that question by itself. I will give them the opportunity if they feel it would be a better service of their interests, to have litigated in this suit now, to have them elect so to do and we will then adopt that course.

THE COURT: Of course there is no reason why such a proposition in court should embarrass counsel

and yet personally I am always reluctant to see such things broached in court for fear counsel may be misunderstood. If there are any negotiations or any proposals of that nature they ought to be taken up with counsel, it seems to me, rather than with the court.

MR. GARRISON: The reason this matter is brought in open court, your honor, if the defendants in this suit ~~at~~ had any purpose to claim that it would have been a better proceeding for them to have this other question litigated in this suit, we now give them that opportunity. We do not want to embarrass them and I do not care whether they make any response or not. I simply wish to give them the opportunity now in open court to elect to have that issue tried in this case, if they so elect. If they do not so elect, that is a matter for them to determine, and if we consider it is necessary to save our rights we shall do otherwise. I should not have embarrassed the court with this although I do not wish to be fronted in this or any other court with the suggestion from them that they would have welcomed that issue in this suit, because it is a fact that a very great deal of the testimony with respect to the prior art at least—well, with respect to any infringement also, that is relevant in one case will be relevant in the other. It may be that when the other case is called for trial if I had not made this statement they would have said, "We would have preferred to try that question in the other suit."

THE COURT: Oh, well, if it wasn't a splitting up, that wouldn't count for anything.

MR. KREMER: Does this all appear upon the record in this case, if your honor pleases?

THE COURT: If, as he says, he conceives he is protecting his right, it possibly should.

MR. KREMER: I don't like this constant colloquy, but if that is so we desire to make this statement: that this is the first time that we have ever heard any intimation or suggestion of this sort; it was not made to us outside of court; neither has it been mentioned before in court.

THE COURT: Well, I think anyhow any right that is to be preserved, would be preserved by offering such a bill or by a modification possibly.

MR. SHERIDAN: While I do not like to cast any aspersions on counsel, but it is very cleverly put. I have refrained from making any remarks to the court at all. These gentlemen know that a defense to this patent is absolutely different from the defense to the patent in suit. We haven't a word in evidence that would controvert the validity of that patent, that would controvert its being an invention, or that we did not infringe it, and to bring that and put it into court would mean an adjournment of this court so that we could prepare our witnesses, four or five weeks. The gentleman that made this motion has had vast experience in court and knows how absolutely impossible that would be.

THE COURT: Well, I suppose there is such a thing as strategy, but it does not count for much before the court. If it was before a jury it might be different. That is why I say I like these things

to come up out of court. Of course I do not criticise counsel. You have your view and so has he, and let's give you both credit for good faith, and as it is you may proceed with the case on trial.

DR. SAMUEL P. SADTLER resumed the stand for further

DIRECT EXAMINATION,

BY MR. SCOTT:

THE COURT: I wish this morning, since the court has on two occasions rather strongly intimated—and that is often done to draw your fire—to say ~~see~~—that it can not see the likeness between this machine in the Fryer Hill publication and the Everson process and the one in suit—Dr. Sadtler has said that he understands that process and I would like him to go into that a little more fully and explain it. He is speaking now as an expert. I don't want you to feel restricted because I have already expressed a tentative opinion.

MR. SCOTT: Very well, sir.

Q. 203. Doctor, will you take that up right now?

A. Perhaps I had better finish the discussion that I was in the midst of as to Kirby, and then take it up.

Samuel P. Sadtler

Q. 204. Well, you had better go into it right now I think, and show the machine.

MR. SCOTT: The Fryer Hill publication is in complainant's record page 738, and the Everson patent is in defendant's record page 607.

THE COURT: It seems to me to be recognized or conceded by both parties that this Fryer Hill publication had reference to the Everson process.

MR. SCOTT: That was conceded in the Hyde record.

MR. WILLIAMS: It was not conceded, if your honor please.

MR. SCOTT: The expert testified to it—I will correct myself; the two experts for the plaintiff testified that the operation described in the Fryer Hill publication was evidently an application of the Everson process, Dr. Chandler, and Dr. Liebmann.

MR. WILLIAMS: I think the substance of that testimony was this: in the Fryer Hill publication there is a reference to the use of sulphuric acid. In the Everson patent there is a reference to the use of sulphuric acid. There is no other resemblance between th two.

THE COURT: I had not noticed the difference or the resemblances, but I had that impression, that both parties were treating it as an illustration of the Everson patent.

MR. SCOTT: I will quote the testimony later, so as not to delay looking for it now.

MR. WILLIAMS: There is no positive evidence

connecting the two; it is a mere matter of resemblances; it must be treated as two separate publications, each standing on its own legs.

MR. SCOTT: That is a matter of the evidence.

THE COURT: Yes, you can argue the evidence later. I wanted to be clear in my conception.

Q. 205. Have you the Fryer Hill publication before you, Doctor?

A. I have.

Q. 206. Now, without reading through this, I would like to refer to the first passage descriptive of the machine that was used.

MR. SCOTT: Near the bottom of the page, if your honor please, about four lines from the bottom of page 738, it is stated that after the ore is prepared, after it is crushed and rolled to such a degree of fineness as to enable it to pass through a 40 mesh screen, the ore, dry, is thoroughly mixed with oil, after which it is placed in a circular tank or receiver—which was represented by the glass vessel we had here, which seems to have been taken away but will be brought back.

THE COURT: Yes, I have a plan of it.

Q. 207. Now, Doctor, I think the best way to make it clear to the court would be for you to take the chair, where you can point out to the court on the drawing there, and you may place letters on the drawing as you go along so that in the record it will be apparent what you refer to, unless the drawing is already lettered.

Samuel P. Sadtler

A. The first element in the apparatus described is the circular tank in which the mixture of ore and oil, previously made, is introduced. The ore while dry, is thoroughly mixed, after which it is placed in a circular tank or receiver. Here we have represented the circular tank or cylinder, this being an outline of it. This is the vessel of glass which has been taken upstairs and will be brought here in a moment; that is the containing vessel. Through the center of that cylinder runs a rotating hollow tube down here. This runs up, and here is the pulley by which the rotation is effected. This rotating hollow tube—there is a perforation which we will mention in a moment, but it is a hollow tube running down to where this door is attached. To the bottom of which tube is attached on two opposite sides a couple of fans. That is what we mean here, the fans. I will go presently to the apparatus and follow it there, but for the moment I am following it on the drawing. These are the two rotating fans, the lower edges of which are unevenly cut, in order to send the lighter particles of the ore and the lighter mixture to the outer side of the drum or cylinder. By rotation of this tube driven by the pulley, these fans are rapidly rotated, and by the aid of these serrations down here there is a very thorough mixing and churning again of the ore pulp and oil mixture, because we have now present the mixture of oil and ore which has been prepared, and the added water. The lighter particles of the ore and oil mixture are sent to the outer side of the drum or cylinder.

Samuel P. Sadtler

This rotating hollow tube is perforated at or near the bottom. Here is the perforation. When the receiver is thoroughly charged and rotation is begun, acidulated steam—sulphuric acid being used—is introduced through the tube. This tube being hollow, allows of that introduction, passing out through these perforations, of acidulated steam. Now, that has a very distinct influence on the separating results; it gives the heat desired, and it gives the notable action of the acid which was referred to by Everson as one of the features of her discovery that, in the presence of mineral acid or mineral salts, for that matter, the selective action of the oil for the mineral is more pronounced and the separation of the mineral and the gangue is more perfectly accomplished. Steam is introduced in the tube and is forced to the bottom of the mixture while the arrastra-like fans—which refers to the construction and appearance of these two rotating fans—arrastra-like. It does not mean that they are to be worked as an arrastra would be worked; they are arrastra-like in shape and in their general appearance, but it is very obvious from the accompanying description there that there is where the resemblance ends. These arrastra-like fans are rotated rapidly, and keep the whole mixture in motion, and the action of the revolving tube, the fans, and the introduction of the acidulated steam—now we have the effect—causes the lighter portion to float to a point just above the center of the receiver. The float is formed here, and that float is an aeration froth

Samuel P. Sadtler

formed by the rapid rotation of a form of apparatus calculated to produce the vortex motion, and calculated to introduce air from above, and thereby entrain air, and the entrained air furnishes the air bubbles, and the mineral particles concentrate in the film of air bubbles and gives the mineral-charged froth, if we take the aggregate of the air bubbles—to congregate slightly above the middle of the cylinder. It says "float to a point just above the center of the receiver." The word float is expressive; that arises and remains as a floating froth or scum—to a point just above the center of the receiver, where there are suspended two semi-circular doors. In the beginning of the operation these doors hang vertically, as we will see in a minute with the apparatus, and their only influence in the early part of the operation is to act as baffles, because it can be clearly seen by the inspection of the special apparatus that has been presented, that a suspended or fixed vertical plate, or a fixed vertical wire frame as seen in the Gabbett cylinder apparatus, will act as a baffle to break up the continuous rotating motion, and thereby to thoroughly aerate, because the breaking up of the continuous motion is what causes the drawing in of air, and a thorough mixture,—and the thorough mixture is accomplished by the aid of these baffles, as well as entraining.

Now, these same semi-circular doors, after this float has formed, are just in the proper position so as to be raised, and they are drawn up so that they

close and form a floor as you might term it, just under the float. I have carefully observed the operation where it was carried out in that apparatus, and I was able to recognize that the floor produced by the drawing up of the two semi-circular fans came very exactly under the level of the float which was desired, and when the oil passed above that, lifting its precious freight burden—that is, there is the float with the oil and its precious burden—then that will cause a water drainage through the perforations in the doors. The perforations are very small, and I will call attention to the fact in my discussion that that Fryer Hill apparatus, in allowing that drainage of the water does not permit the drainage of the heavy oil, and that answers the purpose of allowing the drainage of the water, and the mineral and oil is then carefully removed to settling barrels—and so on. After that we are not concerned with what becomes of it. But in carrying out of the operation, after these doors have been raised, constituting a floor just under the froth, and the water underneath that floor, then, by lowering this jar, it was possible to draw away everything but the froth, supported on that floor, because after the bringing together of the doors, everything else was drawn away.

Q. 208. The lowering of the jar would be just the same as the raising of the doors?

A. Yes. Of course we could, by changing the mechanism have drawn off everything above that floor, but it was very much more convenient to do it

Samuel P. Sadtler

this way, and then the froth was left, and after that it was entirely possible to remove the froth entirely clear and by itself, as was done, and with the aid of a washing bottle, to wash it off into a bottle.

Q. 209. Explain to the court what your reasons are for saying that that is an aerated froth.

A. I am satisfied that after having read the Everson patent, with which I connect this publication, and with which Dr. Liebmann connects this publication, as in his opinion an experiment or an effort to carry out the Everson patent—after having read both of these and seeing the operation of it, I am satisfied that the rapid revolution, and Everson tells us there—"In floating the concentrate after thorough agitation of ~~floating~~ the mass, and detachment of the sand—there are the two main points in the Everson patent. Now that operation is aided by these fans, and aided by the introduction, after the revolution starts, of acidulated steam, and the result of that agitation is the formation of this froth.

The words "and detachment of the sand" refer to the separation of the gangue. The gangue separates, settles, and ultimately is drawn off and of course that leaves the froth. This froth can only be an aerated froth because of the conditions of agitation, in my opinion, being rapidly agitated with the same kind of device that was used in a number of other illustrations."

Q. 210. Has the quantity of ore anything to do with your conclusion regarding the character of the float?

Samuel P. Sadtler

A. The character of the oil which, according to the wording of the Everson patent was 17 per cent, has no effect at all upon the question of whether a froth can or cannot be formed. A froth is readily formed with 17 per cent or a fraction of kerosene oil or a paraffin as described by Everson.

Q. 211. Would any other kind of flotation concentration be effected with 17 per cent of oil?

A. You cannot effect the Elmore form of buoyancy flotation.

Q. 212. For what reason can you not effect the Elmore form of buoyancy flotation?

A. In the first place the amount is absolutely inadequate to raise anything more than a very minute fraction of the mineral content; and the second place the agitation absolutely bars it. The agitation she describes absolutely bars the getting of the Elmore effect.

Q. 213. What authority have you for that statement?

A. It has been testified to by experts on both sides and particularly by Dr. Leibmann that the Elmore process is to be carried out with as little agitation as possible. I have myself carried it out with the greatest care and using different kinds of oil, the thick viscous oil, to carry out the Elmore process in a bottle, slowly revolving, and was able to get the Elmore effect with very slight evidence of the breaking up of the compact layer. With a thinner oil than the oil residum described by Everson you cannot get the same result.

Samuel P. Sadtler

Q. 214. Did you ever compare the effect of agitation described in this Fryer Hill publication and the Elmore bulk oil process?

A. I have done it independently, following that test of the Everson process with a light hydro carbon of the kerosene type, and got a very excellent froth product with the kerosene; whereas, as altered by trying the Elmore method, I have failed to get a notable result.

Q. 215. Suppose the other conditions were corresponding to this Elmore process and you were to agitate violently with the same kind of oil, what would happen?

A. We would get a froth because we have gotten a froth with very heavy oils, the so-called fuel oils, the heavy oils have been used in a number of experiments.

Q. 216. You might just show the manipulation of that.

THE COURT: I think I remember that pretty well.

THE WITNESS: There is where the——

THE COURT: I think I remember that machine. I remember the experiments very well.

THE WITNESS: I have dwelt upon these experiments which seem to me to show the same—carry out the same principle. That is, the agitating mechanism which is driven with sufficient rapidity is certain in my mind to entrain air as well as to thoroughly admix and bring them all in contact with the sulphide particles, which is necessary if they put this hollow tube

in the center prior to agitating—through that acidulated steam is injected.

Q. 217. Tell the court what that acidulated steam —why that acidulated steam was not used here and what was done instead?

THE COURT: Mr. Dosenbach explained that.

THE WITNESS: To connect these three things together, I connected the working of the Everson patent, I connect the description of the apparatus in the Fryer Hill publication and I connect what was undoubtedly perfectly available to the Criley and Everson publications, in which, while the apparatus is not described, we have the result described very minutely. A thick oil was used in this case and to water heated near to boiling was added enough sulphuric acid to give it a tartish taste. That gives us our acidulated hot water, corresponding to the acidulated steam, which follows immediately after in the Fryer Hill publication as well as in the Criley and Everson. In that case we have stated "enough sulphuric acid to give it a tartish taste". This acidulated water is then mixed with the mass of oil and ore. It does not refer to this question at all of its being injected in the hollow cylinder. "A thick scum of sulph~~ate~~urets r~~i~~se to the surface and ~~is~~ was skimmed off."

Q. 218. Doctor, now that you have been referring to this subject and the use of the word scum, I think it would be a good time for you to state your understanding of the word "scum" and how it has been used in these various patents in litigation?

Samuel P. Sadtler

A. I have made a study of that because it seems to have some interest. I have made a search of the way in which the terms "froth" and "scum" are used in the various patents of the Minerals Separation, Limited, taken from the patent records. I have found nine English or American patents which I will enumerate and state how they used that term. To begin with the United States patent 835,120, which is the patent in suit, this patent uses the words "froth" or "scum" as synonymous in the specifications at four different places, sometimes saying "froth" or "scums" and sometimes "scum and froth". British patent, 7,803 of 1905, which corresponds to this foregoing United States patent, that is the patent in suit, also uses the expression "froth or scum" in four different places, taking them as synonymous terms. United States patent 835,143 of November 6th, 1906—that is the same date as the patent in suit—to Sulman, which is sometimes referred to as the boiling patent in which boiling water is used, uses the expression "froth or scum" to designate the result of the agitation and heat in two different places.

British patent 26,852 of 1908 to the Minerals Separation, Limited, sometimes spoken of as the aromatic hydroxy-compound patent uses the expression "coherent froth or scum" twice, and once the additional expression "froth or scum".

United States patent 962,678 of June 28th, 1910, which corresponds to British patent 2,359 of 1909 also uses the expression "froth or scum" and once the expression "coherent froth or scum".

British patent 28,173 of 1908 to Sulman and Picard sometimes spoken of as the alcohol patent, uses the expression "coherent froth or scum" twice in the specification, and in three of the six claims they use the expression "froth or scum".

British patent 2,359, of 1909, to Greenway, Sulman & Higgins, known as the soluble frothing agent patent, uses the expression "froth or scum" three times and once also the expression "coherent froth or scum".

British patent 23,870 of 1910, to the Minerals Separation, Limited, and Nutter, uses the expression "froth of scum" three times in the specification and once in one of the claims.

United States patent 1,099,699 of 1914 to H. H. Greenway for aromatic hydroxy-compounds uses the expression "froth of scum" in the specification. That is the series of patents considering all of them as either taken out by or assigned to the Minerals Separation Limited, and it represents their use of these terms "froth" of "scum".

Q. 219. I have found one of these passages in the Hyde record, page 544 of the complainant's record in the Hyde case, Dr. Leibmann says: "The Fryer Hill publication of 1889 is clearly a further development of the Everson patent."

A. That is what I referred to.

Q. 220. Then he goes on in connection with that, coming to the Criley-Everson publication that the doctor just referred to and quoted, Dr. Leibmann

Samuel P. Sadtler

says: "The Criley-Everson publication of 1890 is a modification of the Everson process as described in the Everson patent" and then goes on to discuss that, and I think anyone such as Dr. Leibmann and Dr. Sadtler, would see the earmarks are all there as to the relation of the two publications, both as to the time of the publication and the date of the operation and the kind of the operation."

MR. WILLIAMS: I can also give your honor one or two references on that topic. I suppose it is timely.

THE COURT: Yes.

MR. WILLIAMS: On page 388 of the same volume, volume 2, complainant's record, Dr. Leibmann says in answer to 8-Q: "The extract from the Daily Herald Democrat of October 30th, 1889, refers to a new method of treating dry silicous ores and an experiment of the concentration of such a dry silicious ore containing silver is described therein. There are several facts which induce me to believe that this extract refers to an experiment according to the previously discussed Everson invention, to which some new developments have been added. The extract states that the new method referred to and was suitable for the treatment of silicious ore. A similar statement is contained in Everson's specification. It is further stated that the ore treated was an ore containing silver and a concentration of the silver particles was obtained. Everson states that her process will probably only be valuable for the treatment of ores containing precious metals, such as gold, silver and copper. Ac-

cording to the report, the ore is, after being crushed and while dry, mixed with oil, which again is in accordance with the Everson process disclosed in 348,157. The quantity of oil to procure thorough mixing of ore and oil must be somewhat similar to the quantity specified by Everson. The apparatus is new and apparently also the mode of agitation which is described." And then I do not wish to read further. And then there is a reference to the arastra-like fan, and the fact that the arastra is a slowly moving, grinding apparatus which is well known in mining. But I think there are some one or two further matters in defendant's record. There is a concluding statement which made it quite clear that this was just what you might call a resemblance in particles and nothing more. I can't put my hand on this just at this minute and I won't ask the court to stop for it. That was in another suit.

THE COURT: It is in the record you say?

MR. WILLIAMS: It is all in the record.

MR. SCOTT: Doctor, I think you may proceed with what you were discussing.

A. When court adjourned I was discussing the Kirby patent and had spoken of the first step and the second step of the Kirby patent and the fact that we could not consider the result, in the light of what would be accomplished by one of these taken separately, but Kirby intended them to be taken as a first and as a second step, the first step to be followed by the second; and he points out that the second step is

a supplementary step. I proceed now to the quantity of oil used by Kirby. When we come to consider the Kirby patent, 809,959, when we come to consider it is the thin, distillable hydrocarbon oil indicated by Kirby as adapted to his purpose, we have several things to note. In the first place it is entirely insufficient to allow us to practice the Elmore buoyancy oil process which requires from 100 to 300 per cent of oil, reckoned upon the ore. Moreover, it is not the type of oil that is needed for the successful practice of the Elmore process, namely the viscous oil of the character of petroleum residum, of heavy gravity, and distinct viscosity. This thin, hydrocarbon oil of Kirby would not hold together without flouring—that is a breaking up of the contact layer into separate bubbles which no longer have the power of holding mineral particles by pure buoyancy flotation in the same way that the compact layer does—this thin oil would break up and develop flouring even under a very slight amount of motion used, if carried out by the Elmore method of operation. This I have experimentally verified in the experiment which I have carried out where it was tried in comparison with thick residual oil—I refer to the experiments which were spoken of a moment ago by Mr. Scott, which I carried out using a rather wide bottle in which was placed the ore, pulp and water, on which was a layer of heavy residual oil, and then by agitating that slowly—and the same thing was carried out by other witnesses in the trial at that time—by agitating that slowly we developed the El-

Samuel P. Sadtler

more effect, that is the gathering together in the heavy oil residum layer of mineral particles, where they were held by reason of the flotation power, we will call it, or the buoyancy of this oil, the gravity of the oil being approximately .9 as compared with the gravity of water at 1. So, that there was a flotation power there of .1—that is one-tenth,—and supposing that we had equal volumes. In that way the Elmore effect was carried out and in the Elmore operation that was described in the California Journal of Technology it will be remembered that there was the slow screw working in such a way as to bring entirely in contact the thick viscous oil and the mineral particles contained in the pulp and thereby to cause the thick oil to take up those particles. That was a slow motion and was comparable with what was done in a small way experiment, in turning the bottle slowly through a number of revolutions. The same experiment, carried out with a thin, distillable hydrocarbon oil gives no result compared with the thick oil, because the thin oil in that turning process easily would develop the result called flouring and it is itself, because of its slight viscosity, incapable of holding its load without dropping very ~~rapidly~~ readily, so that it is notably inferior and has always been recognized in the practice as inferior to the thick residum oils which are particularly adapted to the Elmore process and, as was stated a moment ago, using the same amount of oil and the same mixture of flotation pulp and applying the rapid agitation method you get a result analogous to

P. 3668, L. 18, insert "in a small test experiment" after (,)

Samuel P. Sadtler

what is gotten in the square jar there with 25 per cent of kerosene; that is a permanent froth which remained heavily mineral-laden. Most important of all, however, in considering this question of the use of a thin hydrocarbon oil by Kirby in that account is the violent agitation of thin hydrocarbon and the ore pulp, in his first patent. That, of itself—that alone, that is the violent agitation alone takes this Kirby patent out of the bulk ore category and brings it into the aerated and agitation class. If you can eliminate the first step of Kirby and for a minute suppose the Kirby process carried out by this slow rotation of his form of apparatus with these arms, and the injection of air, you might have a combination of buoyancy flotation with a certain amount of ore particles raised by air bubbles, as has been described by other witnesses; but you cannot tear the Kirby patent in half and eliminate the first step, which is violent agitation. If you practice the first step, the results are such as make it impossible to have the Elmore result or the Elmore process.

The next point I desire to take up is: Will we get a satisfactory metallized froth with this thin distillable hydrocarbon of Kirby used in the amounts indicated by him? That this can be done with entirely satisfactory results was shown here in court twice, first in the experiment with the square jar with that milk-shake mixer used by Mr. Phillips, and of which the results are still there; and the other time by Mr. Dosenbach in the glass jar machine using a form of agitating ap-

paratus very analogous to that shown by Kirby and obviously allowable under the Kirby patent, because as I said yesterday in testifying on this matter, the Kirby patent is a process patent illustrated by one form of apparatus but not tied up to that. And as I also said yesterday at the time of the Kirby patent application there were two very excellent agitating and aerating forms of apparatus known and particularly known in this art, the one being the Gabbett cone mixer and the other being the Johnson mixer, both of which were equally available in carrying out this, with the third form which is here referred to by Kirby. Now, the next question I take up is what was the nature of the froth produced by Kirby?

The froth produced by the carrying out of this first step of the Kirby process being the thin distillable hydrocarbon in the amounts as stated by him to be 25 to 75 per cent, the froth produced is an aerated froth, in which the air entrained by the rapid agitation with the form of apparatus illustrated by Kirby produces the air bubbles. The kerosene forms the material which holds up the oil films inclosing the air bubbles and in the presence of the air bubbles throughout the agitated mixture the metallic sulphides concentrate, in these oil films, stabilizes them and gives us therefore as a product a stable, mineral-coated air froth, which is the vital part of the aerated froth, mineral coated of the patent in suit.

This is the result, too whether we use the smaller or the greater amount of oil indicated by Kirby. I

Samuel P. Sadtler

have personally carried out experiments in which I used 25 per cent of kerosene in practicing this first step of the Kirby process; I have used 75 per cent kerosene in the same form of apparatus and have obtained excellent, stable mineral froths, in both cases. They are thicker when using the larger amount of oil with sufficient agitation. The only difference in the result using from 25 to 75 per cent was a more copious mineral coated froth where the larger amount of oil was used. I, in fact, have carried out experiments using 5 per cent and running up to 75 per cent of kerosene.

I now would like to take up for a moment and discuss a dissenting opinion on this matter. I have expressed myself just now as to what I considered was the character of froth produced in the Kirby process, that it was an aerated froth and described it. I now desire to turn to the opinion of Dr. Leibmann on that matter as given on page 437 of volume 2 of the Hyde original record, complainant's record.

Q. 221. Complainant's record?

A. Complainant's record, page 437. Dr. Leibmann there says: "Kirby's process consists in the separation of minerals from ores: (a) partly by buoyancy flotation; (b) partly by lifting the aggregates of mineral in oil, which are at the bottom, by air bubbles to the top, and removing the products of (a) and (b) together." I do not agree with Dr. Leibmann in this matter. I believe that this statement of his would make the first step—he puts it in two parts, a and b

Samuel P. Sadtler

—this would make the first step of the Kirby process, using a thin distillable, hydrocarbon and violent agitation as described in the section (c) in the specification to have as its result buoyancy flotation. Now, I have shown, in discussing this matter a moment ago that that is absolutely fatal to any Elmore result, and we cannot get buoyancy oil flotation if we practice honestly and as described in the patent the first step of the Kirby process. The operation of the second step, of slow agitation, is described by him as producing the lifting of mineral in oil, to air bubbles—of air bubbles, to the point—

Q. 222. As described by Dr. Leibmann, not Kirby?

A. As described by Dr. Liebmann as having the result which is mentioned in his statement of the second part of the result. That is a supplementary process and probably has that general result there stated. There was a slow additional raising of mineral particles, and undoubtedly by the aid of the injection of air and the currents produced thereby, which supplements the original result of the violent agitation.

Now, a few pages further on, in the same record, on page 442, in the continuation of Dr. Liebmann's testimony, near the middle of the page, Dr. Liebmann says: "The experience which I have gained from experiments makes me doubt whether the assertion made under No. 3, viz., the possibility of the use of a thin hydro-carbon for the purpose of the recovery of the minerals is a fact. In ~~any~~ my view of it, no thin oil can be used ~~to any~~ with advantage, and the patentee

Samuel P. Sadtler

himself describes that the mineral collected at the bottom of the layer of thin oil, which is near the water surface." Dr. Liebmann has here said that in his view and in the light of his experience no thin oil can be used, which I think simply states the weight of Dr. Liebmann's further experience, because I take now his second view rather than his first view—and that is in the same line with mine, that you can not use thin oil to advantage in trying to practice buoyancy oil flotation, and he doubts, therefore, whether the thing is practical. I doubt whether it is practical, but I see the point of the use of thin oil by Kirby if we practice the Kirby process in its entirety. Dr. Liebmann has well stated the difficulties of using a thin hydro-carbon oil for buoyancy flotation, and if we add to this statement the fact that from 25 to 75 per cent. of this thin hydro-carbon oil is recommended by Kirby instead of 100 to 300 per cent agreed upon as needed for the Elmore buoyancy flotation, and if we add to this again as an additional element the violent agitation that Kirby advised, I see how impossible it would be to obtain any buoyancy flotation results in connection with the first step of the Kirby process, or as a summary—as a result of the combined steps.

I now pass next, in considering the Kirby patent, to the conditions of the removal of the froth, as stated on page 3, lines 37 to 41 in the Kirby patent. "The rotating movement of which—" And now we have passed the practice of the first and second steps, one

Samuel P. Sadtler

following the other—"the rotating movement of which leads the floating scum of hydrocarbon liquid, air bubbles and concentrates, against the curved skimming bar, which is hung so as to assist and divert this floating layer and cause it to pass into the settling or washing chamber, box No. 29." We have here described a device characteristic of this Kirby patent, which is the exact equivalent of the skimming device which is in daily mill practice; that is, the froth is moved along from the surface of the spitzkasten by the continued motion of a slowly moving bar, which hangs just low enough to move the froth easily, without cutting down below the line of junction of the froth and the water, so that it really moves the froth by taking off the top of it, and the larger body of it, and in that way continually discharges into the launder. That is the case, with the skimming bar here, the movement of this accumulating froth or floating scum, it is called here, and that is just as strong a term as was used in the Minerals Separation patent; the floating scum of highly mineralzed ore bubbles and concentrates into the washing chamber.

Now, we have next on page 4 of this patent the saving of the froth after movement by skimming, lines 12 to 17: "The stream of skimming enters the central cylinder, within which the water and the hydrocarbon separate, the former sinking while the latter, with the accompanying concentrates and air bubbles, floats in a layer as shown." The stream of skimming—Skimming is a very inexpressive word, but re-

Samuel P. Sadtler

fers to what has been taken off by the skimming bar —The stream of skimming goes on, and the water sinks, while the latter, meaning the hydro-carbon with its accompanying concentrates and air bubbles, floats in a layer as shown. There is a clear indication here that we have the same form of combination of concentrates and air bubbles in an aerated froth that was skimmed off, and I consider it to have been the result of the practice of the first and second Kirby steps, one following the other.

We go now to line 17: "The apparatus, No. 42, has its arms revolving gently within this layer, so as to ~~bring~~ up and discharge air bubbles and assist the separation." If we have a compact layer of oil, with only incidentally a few air bubbles on it, this step would be entirely needless; it would have no meaning to it; but it has a meaning as read here. The arms revolving gently within this layer, break up and discharge air bubbles and assist the operation. We have seen in an experiment here the way in which slow rotation can discharge air from an aerated froth; in other words we can get the air out of the froth by slow rotation.

Then again we turn on this same page, further down, to line 31: "The concentrat~~ion~~ which falls to the bottom of the tank, accompanied by the hydro-carbon which adheres to them, are drawn off in a thick condition." That means that the froth and concentrates are drawn off in a thick condition, along with the hydro-carbon adhering to them, through the pipe

Samuel P. Sadtler

No. 45. These descriptions follow clear through to the end of the description of the Kirby process and seem to me assurance that the practice of the first and second steps leaves him to deal with an aerated froth carrying mineral material. The action of the skimming bar and the after treatment referred to here of the concentrate and air bubble mixture are all in accord with that idea. They are not in accord with the idea that we would have here a compact layer of oil carrying in it mineral particles held up by buoyancy flotation, and not connected with froth formation.

I also would like to call attention, before finishing this matter, to claim No. 1 of the Kirby patent. In claim No. 1 of the Kirby patent we have in line 14: "First, violently agitating the mass so as to break up said distillable substance"—meaning the thin hydro-carbon liquid—"into minute globules." Kirby does not say that air is entrained, but I do not see that we can escape that conclusion, if we remember the Kirby form of apparatus and the words "violent agitation." The next following in this claim, "in allowing said mass to settle." That is a step—"whereby a considerable quantity of mineral particles, having become coated with said substance, will float to the top of the mass." Now, that ends the first step, the production of the aerated froth by agitation, the allowing it to come to rest, the separating and rising of the froth as described here, which has become coated —"the mineral particles having become coated with

Samuel P. Sadtler

said substance," meaning the hydro-carbon, will float by reason of the air bubbles to the top of the mass. "And in gently agitating the portion thereof which settles." That gentle agitation is to stir up the portion on the bottom, which is a counterpart of the retreatment of the tailings, in which a certain amount has dropped, and the flowing into the same of a gas for the purpose there stated, of assisting the flotation of said substance; that which is on the bottom—and the mineral particles coated therewith. And then, finally, removing the floating layer.

I would just say, finally, in connection with this Kirby matter, that in my opinion the Kirby process, using from 25 to 75 per cent of a light oil for the production of a mineralized froth, accords entirely with the theory of froth production as I understand it, and as it has been testified to in this trial. The thin hydro-carbon or kerosene, which we will take as an illustration of that, is not of itself one of the class of the particularly frothing oils; it is not one of the class that is so characterized, because of its practical insolubility in water, and its inability to sufficiently increase the viscosity of the air bubble film of and by itself. But, when you add the ore pulp and produce violent agitation in contact with the thin ore pulp, you get a permanent froth, because the sulphide mineral concentrating in the oil film gives the needed viscosity to the film, and the result is a permanent mineralized froth. The kerosene, whether used as 25%

or 75%, contributes the oil film with some concentration in the film, which, when stabilized by the mineral particles, gives us a stable froth in every case, no matter what the proportion of the oil is.

Q. 223. You observed the experiment performed by Mr. Dosenbach, representative of the Kirby patent, did you not?

A. I did.

Q. 224. I presume you can not carry the details all in mind, therefore I refer you to Mr. Dosenbach's description. Part of the description appears on page 1224, extending a little onto 1225, and the rest of it appears on page 1227 of the typewritten transcript. I wish you would just examine the details of that experiment, and state whether that represents what he did, and how it accords with your view of the Kirby Process.

A. I have refreshed my memory by reading the description. I saw the operation carried out, and recall the results. In this case 25% of kerosene distillate was used, which represents the thin distillable hydrocarbon that the Kirby patent speaks of. It was carried out in a glass jar with the rotating mechanism, which in my opinion is the counterpart, the equivalent of the apparatus figured in the Kirby patent. Kirby prescribes violent agitation; it is mentioned in three of his claims in those words, and in the specifications he speaks of thoroughly agitating for the purpose of effecting thorough admixture. I therefore believe that

Samuel P. Sadtler

we had a perfectly fair practice of that Kirby first step in using that apparatus which was used here in the experiment. The amount of oil was taken as stated by him, the character of the oil was that stated by him and the operation was carried out to the end of that first step, with a view of seeing what result was obtained in that first step. The whole of the Kirby machine was not set up, and the practice of the secondary step of trying to recover more of the mineral from the gangue in which it was inclosed and from which it had not been originally raised in the froth—That was not practiced because it did not throw any light at all upon the single question at issue, as to whether a froth is produced in the Kirby process, and if so, what is the character of that froth. I saw the operation carried out, and I recognized, as stated here, the result: "A copious, highly mineralized froth is formed."

Q. 225. The patent in suit refers to the two Cattermole patents. Will you state your understanding of the Cattermole patent No. 777273, and the relation between that process and the process of the patent in suit.

MR. WILLIAMS: Page 714 of the Hyde record.

A. I have before me the patent No. 777273, to Arthur Edward Cattermole. In this Cattermole patent we have the following statement, beginning line 16 on page 1: "The invention depends upon the application of the following facts: First, ~~by~~ when a mixture of

powdered metalliferous matter and gangue is treated with oil suspended in water, that is to say in emulsion, the oil has a more or less selective action, and will coat the particles of metalliferous matter in preference to the particles of gangue, while the particles of gangue will be wetted by the water." That statement of fact was quite well known, and had been disclosed originally by Haynes, and afterwards referred to by Everson, and is also disclosed by Froment; that is this selective action of the oil for the metalliferous particles and the coating of the metalliferous particles in preference to the particles of gangue. That is all that has to be considered for the moment.

Now, the second statement of facts on which the invention depends is as follows: "If the water which is mixed with the oil is acidulated, with mineral, fatty, or other acid, the selective action of the oil will thereby be rendered more marked and deci~~ded~~sive." That was stated very clearly in the Everson patent, and Dr. Liebmann has testified that Everson contributed the feature to the art, that acid aided in the selective action of the oil.

The third statement of fact is as follows: "If the proportion of oil is kept within reasonably low limits, (~~varied~~ differing in different cases according to the nature of the mineral to be treated and the consistency and nature of the oil,) and if the mixture of water, oil, metalliferous particles and gangue be thoroughly agitated, the metalliferous particles that have become

Samuel P. Sadtler

coated with oil will adhere together and form granules, which granules, partly by reason of gravity ~~and~~ or partly on account of their bulk as compared with the individual grains of gangue, will offer ~~larger~~ ready means ~~of~~ for separation in an up-current separator, a jig or other similar appliance." This statement of fact, if considered broadly and with reference solely to the proportion of oil, is not a correct statement, because I have seen in the course of this trial the production of an excellent mineralized froth by the carrying out of agitation in the form of apparatus as shown here, with the Gabbet cone mixer, using a relatively larger amount of oil, which has been considered as the Cattermole proportion, or within the Cattermole limit. That granules can be formed, of course, is true, but I do not consider that the formation of the Cattermole granules is dependent solely or even mainly upon the statement of the proportion of oil, that the proportion of oil is to be kept within certain limits. The experiment which was carried out by Mr. Dosenbach and which was witnessed by me, showed plainly that the production of the Cattermole granules was dependent upon certain conditions of operation, and not upon agitation in the presence of a certain particular amount of oil. The first result in the carrying out of the experiment was an excellent froth. That was obtained under the conditions of rapid agitation with the Gabbett cone mixer, using baffles in the cylinder. Without removing the baffles it was found possible

to break down this froth, discharge the air from it and produce the aggregation of the mineral particles spoken of as granules, in the same vessel with the same mixture, solely by changing the condition of agitation. Therefore I do not consider that this third statement of fact is true in the way in which it is stated, and I do not consider that this attributing the formation of the granules to the proportion of oil alone is an accurate statement.

The statement is made further on that this action, meaning the production of the granules under the conditions stated here, is facilitated if the oil, before the addition to the liquid, is brought into a condition of emulsion in water containing a small amount of soap or other emulsifying agent. That, of course, is very likely, but that is simply a facilitating of the action; that does not involve modifying the statements that I have made, that the production of granules is not dependent upon the conditions stated in lines 29 and 30 of this patent.

Q. 226. Can you explain that apparatus which is shown in the Wolf patent No. 787814, and what its bearing is upon your discussion of these different processes?

A. The Wolfe patent, No. 787814—

MR. WILLIAMS: Complainant's record Volume 3, page 966.

THE WITNESS: The Wolfe patent, dated April 18th, 1905, has some considerable interest, because

Samuel P. Sadtler

it shows clearly an efficient aerating mechanism—an agitating and aerating mechanism for the mixture of oil and a thin air pulp in connection with a spitzkasten, and the obvious intent and plan, as described in the patent also, is the production of a froth in the first vessel shown, and the drawing off of that froth through a short launder or connecting tube at once from the top of the water in the spitzkasten, where it flows, as stated; while, on the other hand, the gangue sinks and is drawn off from the bottom of the spitzkasten, and the flow is further carried then through a side connection from the upper level in the spitzkasten. This connection of the froth producing mechanism and the spitzkasten is interesting as shown at this day. I refer in the patent to the description on page 1, beginning line 61: "The mixture of oil and pulp passes into the hollow cylinder B^1 and the rotation of the turbine wheel, B2, causes a rapid circulation of the mixture downward ~~contained~~ within the cylinder, and upward between the cylinder and the vessel B." Stopping there for a moment I wish to recall that I have already stated in connection with this construction, when I referred before to the Wolfe patent, that Mr. Sulman had stated in his testimony in this record that this was a very efficient apparatus for producing aeration results, because of the construction of that hollow cylinder, which caused it to act as a baffle, and he considered it to be a very efficient baffle for the purpose of preventing continuous rotation within the circular walls of the cylinder.

Samuel P. Sadtler

In line 66, page 1, we have the further statement: "The liquid is continuously discharged from the mixer through the pipe B5, and passes into the separating tank or spitzkasten, and here the sulpho-chlorinated oil adhering to the mineral of the ore, floats, while ~~and~~ the gangue ~~in~~ the water sinks and is removed by the waste pipe C^1." I also find further down on page 1, line 92, the following statement: "By the means thus provided for eliminating the gangue it is possible to treat ores with such a degree of agitation that the ~~this~~ whole of the mineral contents are taken up by the oil, accompanied, however, by a not ~~very~~ inconsiderable portion of ~~the~~ gangue." That is a result which happens in practice constantly and involved retreatment and repeated retreatment to get out of the first tailing the valuable mineral which was not floated in the primary cell.

Wolfe, in this patent, believes that he can remove the gangue which is there by a hot water treatment. We are not particularly concerned with that, because it is not a matter which in my view has any bearing upon the patent in suit; but I only refer to this Wolfe patent for the purpose of calling attention to the action of the apparatus and the type of the apparatus, as an efficient agitating aerating device combined directly with a spitzkasten, and for a purpose which is indicated very satisfactorily when we come to the claim.

I would call attention to claims 3, 4, 5 and 6 of

Samuel P. Sadtler

this Wolfe patent, in which we have the reference to agitation and the reference to separation of the mineral-bearing oil from the pulp, and flotation. The word flotation appears there as the separation method; that appears in four of the claims "Separating the mineral-bearing oil from the pulp by flotation." After having effected a vigorous agitation with an efficient form of aerati~~on~~ng apparatus.

Now, I feel satisfied that we can not practice this procedure of first practising agitation with that form of apparatus, without producing an aerated froth, which holds the mineral, as stated, quite completely, and then if we follow that by a flotation as described here in these claims of the mineral-bearing oil, an air bubble mixture over the top of the spitzkasten, that it is impossible to have anything else than the removal of a mineral-bearing froth.

Q. 227. Doctor, you called attention the other day to the fact that in Froment's Italian patent the expression used in the complete specification of the British patent, that the invention is a modification of what is known as the oil process of ore concentration, was not used—that this expression was not in the Italian patent. Will you tell whether this expression is in the provisional specification of the British patent, and state also, if you have information, what the relation of the provisional specification is to a complete specification.

A. On looking at these patents I find that there

is no word at all in the Italian patent, either in the French or the English translation given here, of that matter, of its having any relation to a previously known oil process. When we turn to the English patent, we find the provisional specification, which was the more immediate contribution of the inventor, I imagine, or, as I understand it, to the patent agent, contains no reference to this connection or supposed connection. The statement in the British patent that it is in any way related to a previous process, only appears finally when we come to the complete specification, which stands in the name of Henry Harris Lake, the patent solicitor, and that is as follows: "This invention has reference to the concentration of metalliferous ores and earths for the purpose of separating and recovering therefrom the finely divided metal or metallic compounds, and consists of a modification of what is known as the oil process of ore concentration." That was a gratuitous addition made finally in the complete specification in the English patent. It does not appear anywhere in the Italian patent, and appears only in this last statement in the English patent, and it has not justification, to my mind, from anything that is found in the patent, English or Italian.

MR. SCOTT: I offer the British patent referred to, No. 10929, of 1910, to Theodore Jesse Hoover and Minerals Separation Ltd., this being the patent to which Dr. Sadtler referred as containing a statement that the Froment process produced a froth.

THE COURT: That is not in the Hyde record?

Samuel P. Sadtler

MR. SCOTT: No, sir; it is an additional one.

MR. WILLIAMS: In view of the fact that it was in the Miami record and I know all about it, I have no objection.

Patent No. 10929 admitted in evidence without objection, marked DEFENDANT'S EXHIBIT No. 216.

MR. SCOTT: I offer a drawing illustrating a picture of the Fryer Hill machine which was admitted in evidence as one of defendant's exhibits.

Drawing admitted in evidence and marked DEFENDANT'S EXHIBIT 217.

MR. SCOTT: You may cross examine.

CROSS EXAMINATION,

BY MR. WILLIAMS:

I would call your attention, Mr. Scott, to the fact that the witness referred to a number of patents in his testimony, ~~and was~~—and one of them was patent 962,678.

MR. SCOTT: I will offer that to make the record complete. I offer patent 962,678 of Sulman, Greenway and Higgins.

Patent admitted in evidence and marked DEFENDANT'S EXHIBIT 218.

Samuel P. Sadtler

MR. WILLIAMS:

X-Q. 228. Did you testify as follows in the suit of Minerals Separation, Limited, against Miami Copper Company, relative to the Fryer Hill publication:

"X-Q. 667. Then you got your thorough agitation out of the Everson patent?

"A. I took that from the Everson patent.

"X-Q. 668. There is not anything here which defines the nature of agitation to your mind?

"A. The only statement I find here is: "Arastra-like fans, attached to the bottom of the tube, keep the whole mixture in motion." That is a very vague statement, and it is not at all as definite as the statement in the patent.

"X-Q. 669. Well, now, this Fryer Hill publication contains no directions as to the quantity or proportion of oil to be used—is that right?

"A. That is right. Those have been taken from the patent.

"X-Q. 670. It contains no directions as to the kind of agitation to be used—speed of agitation?

"A. No, it does not.

"X-Q. 671. And is not associated with any directions representing any definite mechanical structure?

"A. There are none.

"X-Q. 672. It contains repeated statements about mineral laden oil, mineral charged oil; that is right, is it not?

"A. There are several statements.

Samuel P. Sadtler

"X-Q. 673. And yet you will take this article as the basis of a representation in this court that this machine, operating at about 2,000 revolutions per minute, is the machine there described, and that the operation produced in that machine is the operation there described—is that the situation?

"A. I have explained in previous answers that from the dates of this publication, and the publication immediately following it, in which latter publication reference is made by name to the Everson process, and then the fact that the general, very vague outline of this newspaper article is entirely compatible or in accord with what could be done. Following more accurately the directions of the patent, I have been led to consider that it is a description of the experiments carried out in the way of developing the Everson patent." Did you so testify?

A. I think probably you have read that correctly.

MR. SCOTT: Do you wish to compare it, doctor? If you do, you may compare it with this testimony that has been read to you.

MR. WILLIAMS: I have read it with the greatest care. I would like to know whether I have read it correctly.

A. You marked the beginning and the end of it?

X-Q. 229. Yes.

A. And the ending of it is here?

X-Q. 230. Down here.

THE COURT: The better way then would be for the witness to have a copy and follow it.

MR. WILLIAMS: I am sorry that the time should have been wasted. The witness has a copy of it. I thought he had it right here and I wasn't paying particular attention.

THE COURT: Oh, I think he can say that you read it correctly. He will have the privilege of checking it up.

THE WITNESS: I think I answered correctly those questions at that time. I think the answers as stated by you were the answers given at that time.

MR. WILLIAMS: I want the witness to answer the question that I have read it correctly with the understanding that he may correct my reading if I have made any mistake.

A. I believe it has been correctly read.

MR. WILLIAMS: I will read it over again and you will follow me.

MR. SCOTT: The doctor admits you read it correctly, Mr. Williams.

MR. WILLIAMS: Page 1081, volume 2, Miami record.

(Whereupon counsel read the extract from the witness' testimony in the Miami case as previously quoted.)

Have I read that correctly?

A. You have. Mr. Williams, do you wish me to say whether I agree with the statement of the view I there expressed?

MR. WILLIAMS: I don't care for that now.

A. All right.

Samuel P. Sadtler

X-Q. 231. Now, turn to page 1083 of that volume commencing at question 687. I will read the following, and ask you to follow it:

"X-Q. 687. Now, you have referred to the Criley and Everson publication, appearing on page 393 (Ex. Book, p. 17). Now, in that we have the distinct statement that the oil used was a black thick oil? You know that, do you not?

"A. I do.

"X-Q. 688. You have not carried that out, have you?

"A. I have not.

"X-Q. 689. You were asked to consider this publication in question, and you appeared to pay no particular attention to it in your answer. Do you regard, as a disclosure of a metallurgical operation, capable of being carried out, what is there disclosed?

"A. It does not, as a disclosure, give enough details to make it possible to carry it out in a definite and accurate way. It leaves entirely too much to chance.

"X-Q. 690. Will you accept what the Privy Counsel said about the Criley and Everson publication? (Ex. Book, p. 209?) Even if the test process is not to be discarded as a failure, it does no more than give information "that if to a greased mixture of pulverized metal and rock you add boiling sulphuric acid in a sufficient quantity of water in some way a differentiation is effected as between the metal and the gangue." That is quite as complete a statement as is given in this publication. It is a very fragmentary statement.

Will you accept that as a proper description of the extent of the disclosure?

"A. No; I would not accept it for that reason.

"X-Q. 691. You will not agree with the Privy Council?

"A. No."

Have I correctly read your testimony in the Miami case?

A. You have, yes.

X-Q. 232. Are you familiar with the definition of an arastra?

A. I have heard it fully explained and it is in the illustration.

X-Q. 233. Have you seen the illustration in the Century Dictionary?

A. Yes.

X-Q. 234. Representing a vertical arrangement with stones, dragged around by a team of mules, traveling around and dragging it?

A. Yes.

WHEREUPON an adjournment was taken until 2:00 o'clock P. M.

2 o'clock p. m., May 3d, 1917.

X-Q. 235. Relative to the references that you have made to Ure's Dictionary of Arts, Manufactures and Mines, the first of these references was to an illustration on page 332, described on pages 331 and 332. The apparatus is shown in Fig. 1379, and was given by you as an example of a spitzkasten, was it not?

Samuel P. Sadtler

A. Yes, as a separating vessel.

X-Q. 236. And I understand that you said it was a classifier?

A. I don't recall whether I used that expression or not.

X-Q. 237. The description of this appliance says that it is a separating box, which receives slime water, and that the heaviest portion is discharged at the bottom and goes to the buddles or shaking tables. That is correct, is it not?

A. That is so stated.

X-Q. 238. Do you know what a classifier is in ore concentration?

A. I don't know in any accurate way; I only know that the principle is that of allowing the heavier particles to separate, and the lighter ones to pass on and pass relatively successively in the order of their gravity.

X-Q. 239. And as a matter of fact, in a classifier it is the order of the sinking power in water rather than gravity which controls, is it not?

A. The sinking power of the materials in water, yes.

X-Q. 240. Now, the illustration on page 335, this is also a slime separator, is it not?

A. It is spoken of as a form separator, in which the compartments shown, numbers 1, 2, 3 and 4, are to serve for the purpose of receiving minerals of different densities and size, and they deposit successively according to their density as carried along by the

stream of water. That would be, I presume, a classifier, although I do not use the term in any technical sense.

X-Q. 241. On pages 356 and 357 the apparatus shown in Fig. 1419 is described as a dolly tub, or packing kieve. Do you know what that means?

A. Well, I read the description, and I understand what is to be accomplished in this particular use here described of this apparatus. I did not intend to cite the apparatus as one which would be used for that purpose, but as a form of apparatus which, removing that detachable lid, was perfectly adapted for serving as an agitation vessel which would necessarily, if rapidly rotated, entrain air. It was offered for that purpose, for illustration.

X-Q. 242. And in the description it says that as the handle is turned by two men, slime is shoveled into the top. You knew that, did you not?

A. I read the description as given here. It is illustrated as operated by hand power, and a couple of men are spoken of as taking hold of the handle and turning it rapidly. It is very obvious to me that it is just as capable of being rotated more rapidly by a power connection with the aid of a pulley. It does not affect the purpose for which I introduced it, which was to call attention to the form of agitation which would be accomplished by these paddles.

X-Q. 243. Figure 1420 shows the condition at the completion of the operation with the various strata of solid material as they separate, does it not?

Samuel P. Sadtler

A. It does.

X-Q. 244. Referring now to the translation of the work of Agricola I read from the test the description of the apparatus which is shown in the photograph, defendant's exhibit 51. I read this description as follows: "Quicksilver is placed in each tub, across which is fixed a small plank, and through a hole in the middle of each plank there passes a small upright axle, which is enlarged above the plate to prevent it dropping into the tub lower than it should. At the lower end of the axle, three sets of paddles intersect, each made from two little boards fixed to the axle opposite each other. The upper end of this axle has a pinion held by a bearing set in a beam, and around each of these axles is a small drum made of rundles, each of which is turned by a small tooth drum on a horizontal axle, one end of which is mortised into the large horizontal axle, and the other end is held in a flat cup with thick iron plates in a beam. Thus the paddles, of which there are three sets in each tub, turn round and agitate the powder, thoroughly mixed with water and separate the minute particles of gold from it and these are attracted by the quicksilver and purified. The water carries away the waste." Have I read that description properly?

A. You read it accurately, yes, sir.

X-Q. 245. Relative to the first method disclosed in the Everson patent, you testified in the Miami suit as follows, did you not, page 1059, X-Q. 502, "It did not seem promising from a metallurgical standpoint as an

operation? A. No, sir. X-Q. 503. And you have not done it? A. No, sir." You so testified, did you not?

A. I did so testify in regard to the first illustration of the Everson patent.

X-Q. 246. Referring now to your testimony in the Miami suit, page 1067, where you were asked on X-Q. 553 what devices and methods were well known in the art in the wet separation of ores in 1886 you answered: "A. The spitzkasten, or its equivalent, was known and available in that case, or if not by name, its equivalent in the form of some overflow vessel. X-Q. 554. Was there not another device used in the wet separation of ores which was peculiarly adapted for washing out by a complete overflow, to-wit, the water classification apparatus? A. I explained in my testimony yesterday that I was not a metallurgical engineer, and therefore I must decline to say what was known at that time, of wet concentration methods, because I have not studied that." Did you so testify in the Miami case?

A. I did so testify at that time.

X-Q. 247. Referring again to your testimony in the Miami case, page 1056, relative to what you had done in that case as to the carrying out of the Everson patent and the Fryer Hill publication, did you not testify as follows: "X-Q. 477. What you have done, as I understand, is to take the proportions of oil which are described in the patent, and you have done things with them? A. Yes, sir." So far as I have read that is accurate is it not?

Samuel P. Sadtler

A. That is correct.

X-Q. 248. I did not add the final part of the answer because I did not think it adds to the explanation. Now, relative to the description of Froment as a froth which you say you found in certain British patents and particularly British patent No. 23,870 of 1910, I refer you to that patent which is at page 1005—commencing at 1001.

A. The British or the Italian?

X-Q. 249. No, the Minerals Separation, Limited, and Nutter patent 23,870 of 1910. That appears in the Hyde record, complainant's record, volume 3, page 1001. I first refer you to page 1003 which is page 3 of the specification at the commencement of the complete specifications. In the last paragraph there is a general reference, is there not, to processes described in previous patents, including the British patent corresponding to the patent in suit and the British patent corresponding to the solution patent?

A. If you can give me the page and line of the patent I can find it.

X-Q. 250. The last paragraph of page 3 of the specifications, page 1003 of the record. And this statement does not include the Froment patent, is that correct?

A. The statement at that point does not include it but in that same complete specification it is included at the point at which I quoted, in the same complete specification.

X-Q. 251. I didn't ask you that.

A. It is not included at this point.

X-Q. 252. Now, the point to which you call attention was on page 5 of the specifications as I recall it?

A. Yes.

X-Q. 253. Line 22 to 24, is that right?

A. That is right.

X-Q. 254. And the patent states: "The process employed to obtain these froths or scums may be any of the well known flotation processes as described for example in patent No. 12778, 1902; 29374 of 1904, 7803 of 1905, and two others and this 2359 of 1909.

A. That is what I quoted.

THE COURT: Now, I want to understand this clearly. This speaks of producing froth and scum, and then says it may be any of the well known flotation processes, and names amongst others, the Froment patent; is that right?

MR. WILLIAMS: Yes, sir, having become well known by reason of the fact that it was patented, and that the patent was widely published.

X-Q. 255. Now, I call your attention to the fact that on page 3 of the patent wherein the Froment patent is omitted, the reference is to processes—"that have hitherto been used in the practice of the separation of metallic sulphides from gangue." That is true, isn't it?

Let me read that. It is true that the processes which are there enumerated are spoken of as hitherto used for that specific purpose, of separating metallic sulphides from gangue, and they proceed then to par-

Samuel P. Sadtler

ticularize as to their new application of the flotation processes, a separation between metallic sulphides, which was the point of the invention, and for that reason they quoted these prior patents.

X-Q. 256. Now, let us turn to the California Journal of Technology, commencing on page 681, exhibit 47. The first part of this article, up to the point where a reference is made to the foam effect, is devoted entirely to the Elmore oil buoyancy flotation process, is it not?

A. Down to the heading "Laboratory Methods." That part which precedes that is devoted to the account of the Elmore process, and particularly with reference to the question of the supposed further development of it by means of a centrifugal separator. That carries us down to the heading "Laboratory Methods."

X-Q. 257. Now, in the part of the description preceding that heading, and the particular description of the Elmore commercial apparatus illustrated on the first page of the article—that is the Elmore commercial apparatus is it not?

A. I presume it is. It is referred to there as a plant designed by the Oil Concentration Syndicate. I don't know anything at all about the connection that that particular syndicate may have with the Elmore process, but it is undoubtedly referring to the Elmore process.

X-Q. 258. Don't you recognize that as substantially the apparatus that is shown in the Elmore first patent?

A. I can not be quite certain about that, but I am willing to say that it carries out the Elmore procedure in accordance with the spirit of the Elmore process.

Samuel P. Sadtler

X-Q. 259. I now show you the drawing of the Elmore patent, the first process patent, No. 676679, and ask you whether or not the drawing in this California Journal does not show in substance the same apparatus.

A. It shows the same general plan of operating.

X-Q. 260. In reading over this description I find the following: "The mineral laden oil, collected from the separators, is carried to a large receiving tank, B. Here, after being heated, in order to thin it and to overcome its viscosity, the oil is charged into centrifugal machines, where the concentrates are separated out. The oil, free from its load of mineral, is pumped back to the original storage tank to be used again." That is correct, is it not?

A. That is correct.

X-Q. 261. The expression "mineral laden oil" is an apt expression to describe the Elmore float?

A. That is the expression which refers to the way in which the mineral is carried in the Elmore heavy residuum oil.

X-Q. 262. And in the Elmore process heat is not used in the process because it impairs the viscosity of the oil, is that true?

A. Not up to this stage.

X-Q. 263. Not until the separation is completed?

A. Until the mineral has gone into the oil.

X-Q. 264. The mineral has gone into the oil and the float has been overflowed, and after the float has gone into the receiving tank.

A. I don't know anything about the float; I don't

Samuel P. Sadtler

know just how you apply that term in that case, but following the illustration here, the separation of the compact oil layer from the water has taken place, and the mineral is carried in that upper oil layer.

X-Q. 265. And then this description says that the mineral laden oil goes into the receiving tank B, and there heat is applied, does it not?

A. After that, in order to advantageously centrifugate.

X-Q. 266. And also to overcome the viscosity of the oil, that is the language?

A. That is the purpose, yes.

X-Q. 267. And in the process up to the point of the separation, heat must be avoided, must it not?

A. In the Elmore process.

X-Q. 268. Then this description speaks of the oil as a heavy residuum, does it not?

A. It does.

X-Q. 269. And says usually about a ton of oil is kept in operation for each ton of ore, does it not?

A. Yes, usually about one ton of oil.

X-Q. 270. And then it speaks of an advantageous method of separation, whereby "the losses are not greater than from one to three gallons of oil per ton of ore." That is correct, is it not?

A. That seems to apply to this carrying out of the Elmore process, with the steps mentioned, that of thinning it by heat and centrifugate it, and in that way they reduce the relative loss of oil.

X-Q. 271. What is the measure in pounds of one to three gallons of heavy residuum oil, per ton of ore?

A. The specific gravity of the oil is given there as .9, so 100 pounds of that would be 90 lbs.—that is, you would have 90 lbs. indicated there as the weight of a volume corresponding to the volume of the ore.

X-Q. 272. From one to three gallons of oil per ton of ore would be how many pounds of oil per ton of ore?

A. Well, I don't know whether I can calculate that off-hand. I don't know the weight of a gallon off-hand, of liquid of a gravity of .9. I could find it in the table.

X-Q. 273. Well, never mind, I will supply the calculation; I thought you had it in your head.

A. No. I can give you the figure any time that I can take the tables and calculate it.

X-Q. 274. Now, let us turn to the tests to which you have particularly called attention, under the heading, "Test, Molybdenite Ores." Now, the first item which you did not read was the mesh, 30. That is very coarse material is it not, for flotation treatment?

A. The ore here is given in these experiments as 30 mesh in the experiment in which the small quantity of oil was used.

X-Q. 275. And I read the part of the description which you did not read, which refers to Nos. 1, 2 and 3, evidently to the Elmore oil buoyancy experiment, but which is followed by the description of the smaller proportion of oil experiments. "Experiment No. 1 showed the persence of middlings, requiring finer crushing to liberate the sulphide."

Samuel P. Sadtler

A. That was 20 mesh.

X-Q. 276. Therefore that was too coarse for use?

A. For that purpose.

X-Q. 277. "Experiment No. 2 and No. 3 gave practically the same percentage of extraction, but the concentrate in No. 3 was much lower grade than in No. 2." Now, No. 2 was the 30 mesh; that was a little finer, wasn't it?

A. Thirty mesh is finer than the first one, 20 mesh.

X-Q. 278. And No. 3 was 40 mesh?

A. Yes.

X-Q. 279. Now, when they go to forty mesh it says the grade of concentrates ~~were~~ was much lower than it was in No. 2. That is to say when they lower to forty mesh they get a lower grade of concentrate? That is it, is it not?

A. But they change the amount of oil between two and three. There is another element comes in.

X-Q. 280. Yes, but it is only one and two thousand k.g.—2000 gms.?

A. Just as it is given there in the other case.

X-Q. 281. And the amount of ore was 1000 gms. in the number 3 and the amount of oil is just a little more than that, about 1200 gms.?

A. 1200, yes, there is a difference in the two.

X-Q. 282. There is a little difference in oil. That is to say, the proportion of oil to ore is slightly increased as 1000 is to 1200? Is that right?

A. That is the difference between those two.

X-Q. 283. Then it says "A comparison of values of concentrate in number 1, number 2 and number 3

shows clearly that although the finer crushing has freed the molybdenite sulphide from the gangue, at the same time it has produced a larger percentage of fine gangue which, becoming mechanically occluded, in the oil, gives a low grade concentrate." I have read it correctly, have I not?

A. That is correctly stated.

X-Q. 284. Now, following that were experiments Nos. 4, 5 and 6, which it is said "show the results obtained by treating separate samples with small quantities of oil in a salt solution, and agitating violently to produce the foam effect." I have read that correctly, have I not?

A. That is correct.

X-Q. 285. "This method gives the highest grade concentrates of any of the direct treatments here outlined. In experiment number 6 only about 10 c.c. of oil was used for 100 gms. of ore. This gave an extraction of 75 per cent with concentrates running 32.4 per cent molybdenum sulphide." The experiments which gave the best extraction or the best record was the last of these three with 8.9 per cent of oil, was it not?

A. Yes, sir.

X-Q. 286. And the experiment which gave the poorest extraction or recovery was the one in which 2.1 per cent of oil was used, is that right?

A. It is in that report.

X-Q. 287. And the recovery there was 43.5 per cent, and when the amount of oil was increased to 5.3

Samuel P. Sadtler

per cent the recovery was 47 per cent; and when the oil was increased to 8.9 per cent, the recovery was 75 per cent. That is correct, is it not?

A. I think something must be borne in mind, to-wit, the number of treatments indicated there.

X-Q. 288. Yes. You didn't explain that. Suppose you explain it?

A. I think that that indicates that there was a second treatment and a third treatment.

X-Q. 289. That is after the manner of the Elmore process, when you put the things through a centrifugal and thereby extract the oil and then send it through again, isn't that so?

A. This has nothing to do with the Elmore process whatever; there is no connection with centrifugation here. It is the foam effect. The foam effect is not centrifugation.

X-Q. 290. I call your attention to the fact that that column headed "Number of treatments" runs through the upper three experiments, which are Elmore experiments, and there we have number of treatments four, number of treatments three, number of treatments three, so you know what they mean is the Elmore process, don't you?

A. No, I can't say that I do.

X-Q. 291. Well, it is described in this article, professor, that they put them through the centrifugal and used it over again?

A. Under it, by the use of a series of cylinders. But the application of the Elmore method under the

head of additional treatment is not possible where we are trying a foam effect. The foam effect is tried and shown there and described by these writers and it has no possible application to a second or third following of the Elmore; haven't anything to do with it, not the slightest.

X-Q. 292. I don't think you have figured that out, professor?

A. I have not figured out what this "treatment" means because it is not indicated, it is not indicated at all, and therefore I am not prepared to say that that has one value or the other, but I am prepared to say that whatever it is it is not a following of any step of centrifugation or anything else of the Elmore process. That is practically out of the question with the foam method of operation.

X-Q. 293. Now, everything that we have been considering in this table is under the heading "Laboratory methods," isn't it?

A. No, the heading in the case of tests, laboratory methods describes what was found on page 36 of this California publication, laboratory method applies to what there follows: "The mixing or agitating can be done in two different ways. The charge may be agitated very gently, the oil being kept in a single lake, and broken up as little as possible, consistent with a thorough contact of pulp and oil, or the charge may be agitated so violently as to dash the oil up into a foam or froth full of air bubbles, thus a very thorough contact of oil and pulp is obtained. Each method has its

Samuel P. Sadtler

advantages and disadvantages, and these are discussed later." Now, this is what is implied when he begins the discussion of laboratory methods and the way in which this laboratory—these laboratory methods are carried out is farther described on the same page, page 36: "Three methods of mixing may be used. 1. By inverting the tube several times, thus allowing the ore to fall through the oil. 2. By rotating the tube in a horizontal position, thus throwing the pulp upon the surface of the lake of oil. 3. By violently shaking the tube, thus producing the foam effect, or at least shattering the oil into small globules." Then after that we come to the tests. These tests are not necessary any longer to be considered as illustrative of these laboratory methods, but they are the application of the laboratory method to particular tests of ore for the purpose of arriving at a knowledge of results.

X-Q. 294. Now, just read the first paragraph there, that headed "tests"—molybdenite ore. Read it aloud.

A. "The ore treated was low grade—" that is what you mean?

X-Q. 295. Yes, read that paragraph?

A. "The ore treated was low grade with the values fairly disseminated. The gangue minerals were orthoclase and quartz. Samples were crushed to 20, 30 and 40 mesh, and treated in percolating tubes as outlined above. The details and results are given in the following table."

X-Q. 296. Don't that make it pretty clear that these were laboratory methods?

A. In the sense that they were small operations, of course they were laboratory methods; but now applied in a quantitative application. The distinction I make is not as between small scale operations and mill operations. That is not my distinction. My distinction is as between the figures which I described. "Methods of operation" as here discussed in this operation are specific tests, and here are some of these.

X-Q. 297. Now, is it not a fact that the only operation described in that table and described there as a laboratory method ~~in the per described there is a laboratory method~~ in the percolating tube carried out with less than 100 per cent of oil and showing a recovery that has any metallurgical value is the operation with 8.9 per cent of oil to the ore?

MR. SCOTT: That certainly is objected to. The doctor has just testified that this was not necessarily a laboratory method, and the question contains the statement that it is.

THE COURT: Well, that different application of terms is all. I think he will not mislead the witness. I cannot drive the doctor to accept his terms or he is not to be driven to accept the doctor's terms.

MR. WILLIAMS: I want to shorten up, your honor.

A. I have granted that these tests were carried out in percolating tubes as stated specifically. I don't call that laboratory methods, but the application of laboratory methods in practice as such on a small scale, but still quantitative because the matter was followed out

Samuel P. Sadtler

with care in the weighing and followed out with care in the examination of the concentrate, in the molybdenum sulphide which you will note runs higher in experiments 4, 5 and 6, than in experiments 1, 2 and 3, and that is the one case we get the maximum percentage of extraction. In the case of experiment 6 also were small scale experiments carried out in percolator tubes and they represent the application of laboratory method in practice.

X-Q. 298. You have not answered the latter part of the question. Please read the question.

(Question read as follows: "Now, isn't it a fact that the only operation described in that table and described there as a laboratory method ~~in the per described there is a laboratory method~~ in the percolating tube carried out with less than 100 per cent of oil and showing a recovery that has any metallurgical value is the operation with 8.9 per cent of oil to the ore?")

MR. WILLIAMS: The question whether that is not the only one of these less than one hundred per cent operations which shows a recovery having any metallurgical value?

A. I am not prepared to say that was a recovery of metallurgical value because the statement follows immediately after that that these retreatments were not merchantable, but would have to be reconcentrated; but it represents the highest figure in percentage of extraction and the figure is also higher as I say in the value of concentrate, that is *molybdenum sulphide,* than those of the earlier ones. I can't characterize it any more exactly than that.

Samuel P. Sadtler

X-Q. 299. That is to say in that you only lose 25 per cent of your metal in the operation while in the other two you lose respectively 53 per cent and 56.5 per cent, that is right, is it not?

A. In this first concentrate product those are the figures and the other amounts that you have mentioned are yet to be recovered by retreatment, as specially stated by the authors.

X-Q. 300. And as you read it in experiment 5 there has been a retreatment of the original and with retreatment the recovery has been 47 per cent, is that right?

A. I am not able to say what that means as to the number of treatments. It possibly was not what he called reconcentration.

X-Q. 301. Yo do not know what it means?

A. I do not know what it means. That is correct.

X-Q. 302. And then down near the bottom of the page, as you have the article in the fourth page, following the table, we have a description, have we not, of a No. 9 concentrate having been brought up to fifty percent of molybdenum sulphide?

A. That is reconcentration; that is bringing from—32.4 up to 50.02.

X-Q. 303. And apparently that was the climax of the operation that these students performed.

A. That is as far as they reported it.

X-Q. 304. Now, following this description of the test with molybdenite ore we have a description of tests with copper ore, have we not?

Samuel P. Sadtler

A. Yes, sir.

X-Q. 305. And no mention of anything less than substantially Elmore oil buoyancy proportions, is that right?

A. We have mention of 1.2 k.g., which means 1200 gms., treated there in a large percolating tube with 500 c.c. of oil which is less than the Elmore amount.

X-Q. 306. And then it states that it was gently agitated for twenty minutes, doesn't it?

A. Yes.

X-Q. 307. So that must have been an Elmore process, must it not?

A. I can't say. The amount of oil was not sufficient for Elmore. I don't know what he means by "gently agitated in a percolating tube."

X-Q. 308. So you think that might be a foam effect?

A. It is some form of agitation.

X-Q. 309. You don't find any description which you can identify as a foam effect, do you, under this heading of copper ores?

A. No, sir.

X-Q. 310. Nor under the heading of gold ores, do you?

A. I believe not.

X-Q. 311. Now, in conclusion, on the last page of the article, the statement is, is it not, that the oil was thrown into a froth which was heavily charged with air or other gas?

A. That is correct.

Samuel P. Sadtler

X-Q. 312. And then follows the statement that this gas of course gives a great~~er~~ly increased buoyant force. That is right?

A. That refers to the bubbles so obtained. The bubbles of gas have greater increased buoyant effect.

X-Q. 313. Then it says the oil in this condition assumes a certain load of mineral and holds it in a very stable condition. That is right, is it not?

A. Yes, that is this froth condition.

X-Q. 314. And further it says, "The charge does not settle and overload on standing" and describes the result of the operation?

A. Will you finish that sentence if you please?

X-Q. 315. "As is the case of the lake effect."

A. Yes, there is the distinction made. There is no overload here in the froth effect as there was in the lake effect.

X-Q. 316. What is overloading in the lake effect?

A. The gradual dropping away of the mineral particles from the layer of oil in which they have been first taken, and on standing that frequently is said to result, but by reason of the insufficient buoyant power of the oil or with any little disturbing of the compact layer of oil, this overloading becomes imminent and a dropping out of the mineral takes place.

X-Q. 317. And, as a matter of fact, the mineral and oil together drop out, don't they, the oil being overloaded and not buoyant enough to float, the oil then goes with the material.

A. I am not prepared to say how much oil goes

Samuel P. Sadtler

with the material that drops, but it is substantially as described. Ore dropping out of the mineral, it must of course be oiled.

X-Q. 318. Haven't you seen these blobs drop down from the Elmore float, here one afternoon?

A. Yes, sir.

X-Q. 319. And these blobs are overloaded themselves so that they can't float by buoyancy? That is true, is it not?

A. It is merely because the buoyant effect of the oil does not suffice to hold up the mineral, and in pulling away it drags oil in some degree.

X-Q. 320. And that oil and mineral together are not buoyant enough to rise to the surface That is right?

A. No.

X-Q. 321. Now, the conclusion is the foam effect is best adapted for light, flaky mineral such as molybdenite? What is that character of lightness and flakiness which they there refer to?

A. Well, molybdenum crystallizes in flat, flaky crystals, and its cleavage and general structural character is that of a flaky condition; and as they tried the experiment with molybdenite and got results which satisfied them, they have assumed that this was the typical form of mineral adapted for the foam effect. Whether that conclusion would have been modified on a larger amount of experimentation is another question. That was their conclusion as stated here, based on what they had done here.

X-Q. 322. Now I will refer you to the record in the Miami suit, page 1183. Did you not in your testimony there in answer to re-cross 1368 characterize what is described in this article in the California Journal of Technology as "that little foam effect" in the California publication?

A. I did so speak of it because the operation was a small operation and the little foam effect was entirely so characterized because it was done in a percolator. There was no intention to distinguish between much or little volume of foam in any such relative way, but the little foam effect referred to the small tube experiment.

X-Q. 323. Now, we will turn to the Kirby patent which appears on page 738 of the Hyde record, and first we will take on page 738 the drawing on the first page.

A. I have the first page of the drawing.

X-Q. 324. Now, the apparatus indicated by the letter A is the apparatus described in the specification as the mixing tank is it not?

A. Large A, yes, sir.

X-Q. 325. And small a is the revolving plow described in the specification?

A. Yes.

X-Q. 326. Now you said that that curved dotted line above there represents a vortex?

A. I did.

X-Q. 327. Do you adhere to the view that that

shows a vortex with an opening shown for the purpose of admitting air to the bottom of the vessel?

A. The reference in the patent to the arrows and what they indicate—

X-Q. 328. You have not answered the question. Answer first and then you can explain.

A. I do ~~not~~ consider that that curved line illustrates the direction of a vortex.

X-Q. 329. Well, that is the whole question.

MR. SCOTT: You may explain now, if you wish.

A. I consider that it refers to a vortex, and I think I am justified in taking the two things together, the statements of the patent that the direction of the arrows indicates that there is a current, as stated here—"which result is facilitated by the current as created in the charge by the action of said plows, the direction of said current being indicated by the arrows in Fig. 1." Now, if we have the current established as indicated by the arrows, it is undoubtedly a vortex. I think the appearance of the curved line was an illustration of a vortex, designed to additionally confirm that statement, that there are produced a series of currents which, with rapid rotation means the production of a vortex such as is very easily seen by any of these rapid rotations when in motion, and that means the entraining of air.

X-Q. 330. MR. WILLIAMS: Now, how, according to the specification, is that mixing tank operated; what functions are performed in that mixing tank according to the specification?

Samuel P. Sadtler

A. I find that on page 1, line 68: "First, in thoroughly agitating it together, the pulverized ore or mineral material. B, enough water to make the said pulverized ore a flowing pulp. C, a solution of bitumen in addition to a distillable hydro-carbon liquid, as kerosene. These materials to be so thoroughly agitated together as to finely subdivide said solution into small globules and bring said globules into contact with substantially all of the pulverized mineral particles which will, by preference, adhere to them.

Now, there are statements as to what are the components of the mixture there, statements that we have thorough agitation of the mixture; statements that the materials are so thoroughly agitated as to be finely subdivided in the solution in small globules.

X-Q. 331. What is the solution?

A. The solution, meaning kerosene holding some bitumen in solution.

X-Q. 332. That is to say, the oil is broken up into small globules of oil; that is right, isn't it?

A. Yes, then it says, "and bring said globules into contact with substantially all the mineral particles which will by preference adhere to them." I simply say—I don't add anything to it—but I simply say that you cannot realize that result without entraining air, and therefore air bubbles are there, which, with the kerosene or kerosene solution, is the film-forming material or effective in forming the froth.

X-Q. 333. That is to say, entraining air and keeping it?

Samuel P. Sadtler

A. Entraining air so as to produce froth. It may be called beating in, just as truly as the action of the cone-separator is called beating in.

X-Q. 334. Then you think that in the mixing tank a froth is produced?

A. I do.

X-Q. 335. Now, where is that froth separated in this apparatus?

A. If the mixing tank is used as a separate feature, it has to pass into the separator.

X-Q. 336. The separating tank?

A. The separating tank. If, as Kirby says, one tank serves both purposes, than the froth is raised in the separating tank.

X-Q. 337. I asked you about the mixing tank. Is the mixing tank ever used as a separating tank?

A. No, it is not.

X-Q. 338. Therefore the froth is never taken out in that mixing tank, A, according to that specification; that is right, isn't it?

A. It is not calculated to be taken out there; it is calculated to be taken out in the tank where we have shown the skimming device.

X-Q. 339. That is tank B; that is the separating tank?

A. That is right.

X-Q. 340. And now, everything else which you have described as supplementary takes place in that tank B, doesn't it?

A. After the conclusion of the thorough agitation, whether that takes place in one tank or the other.

Samuel P. Sadtler

X-Q. 341. Well, it does not take place in the mixing tank, you admit that?

A. The second operation is not calculated to take place in the mixing tank.

X-Q. 342. And there is no description of that in this patent—of any separating operations taking place in that mixing tank; that is true, isn't it?

A. That is true, yes; I have said that.

X-Q. 343. So that whatever separation takes place in the apparatus shown in Fig. 1, takes place in the separating tank B, that is right, isn't it?

A. This is so figured.

X-Q. 344. ~~You think~~ separating tank B would have the streams of oil flowing in—in that we have streams of oil flowing into the pulp; that is one of the things that is described?

A. I don't quite understand what you mean there.

X-Q. 345. I am taking the words of the specification.

A. What do you mean when you refer to streams of oil?

X-Q. 346. The language of the specification is "fine streams of the solution," page 1, lines 84 and 85.

A. That is in the second step.

X-Q. 347. I am talking about the separation in the separating tank B.

A. That is the separation; that is supplemental. If you will read the paragraph beginning "Second" we have this stated clearly: "In allowing the hydrocarbon coated particles to flow to the surface of the

Samuel P. Sadtler

mass." That is his separation; "and in rendering this separation substantially complete by a second step."

X-Q. 348. Rendering that separation substantially complete?

A. "By gently agitating the mass and injecting gas into the same, and preferably also discharging into the mass fine streams of the solution." That is the secondary step. It is not any part of the step which forms the froth, and the froth has already floated to the surface before that is started. That is the clear meaning of these words.

X-Q. 349. That is to say, what you call the primary step and what you call the secondary step take place B, in the separating tank~~s~~, don't they?

A. The froth is entirely separated there in tank B; you are correct about that.

X-Q. 350. Now, in this tank B we have first the material, which has been agitated in tank A, and that is the material and all of the material which flows into the tank B; that is right?

A. That is right, just as it flows off into a spitzkasten.

X-Q. 351. Now, in tank B we have fine streams of the solution or oil discharged at the bottom of the tank, have we not?

A. It may be done.

X-Q. 352. It is so described, is it not?

A. It says it may be done: "By injecting gas into the same, and preferably also discharging into the mass fine streams of the solution." That is one of the

supplemental steps, just as the discharging of the gas is, and it may be done. It is not prescribed as a necessary feature, but I suppose he considers it an advantageous matter.

X-Q. 353. In the description of the operation of this apparatus shown in the Fig. 1, this is said, is it not: "That the hydro-carbon liquid is delivered through small pipes parallel with the side hollow arms through outlet 25—25." That is the description, is it not?

A. I must connect that up first. That is correctly stated as to what takes place when the hydro-carbon liquid is used in that way, "preferably discharged in fine streams" as part of the second step.

X-Q. 354. But it does not say here that you do it preferably; it says in this part of the description that you do it, isn't that right?

A. There is no question here—no qualification here; it just says that it is delivered in that way.

X-Q. 355. And it is true, is it not, also that "gas is injected into the pulp in the separating vessel B." That is true, is it not?

A. That is correct. "Injecting gas into the same" is found on page 1.

X-Q. 356. And that is accomplished through air jets in the rotating stirring plow, is it not?

A. We have figured in Figure 1 the same form of rotating apparatus which is operated at two different stages of the operation, and operated at different rates of speed and for different purposes. The operation in

the first, or mixing tank—or if you perform that operation first in the separating tank and make one tank to function for both, that operation—that is not involved in the injecting of the air in the way that is now mentioned; that only comes in when the rotating apparatus is slowly rotated in the second step, and for the purpose of yielding small rising bubbles of air which will carry out of the gangue the mineral which was not raised in the froth in the first step. That is clearly shown.

X-Q. 357. And your first step and your second step are completed in the same vessel, is that right?

A. They may be; not necessarily—oh, yes, they are both completed in the same vessel, you are right.

X-Q. 358. Of course I have in mind, as you have repeatedly said that it is described in this specification as a modified instruction that you can do everything in this second vessel; that is true?

A. That is true; it says that that can be done. That is stated on page 3 of the patent, line 115. "This separate tank for performing the mixing operation is not necessary for my process, although it is preferable in some cases; as where a continuity of discharge is desired. The mixing may be done just as well in the separating tank, which can then be termed the mixing and separating tank, all in one. It is merely necessary to rotate the agitating apparatus rapidly when mixing" —and that is when I say the froth is formed—"and rotate slowly when the separation is being made." There are two different stages and two results.

Samuel P. Sadtler

X-Q. 359. And one separation?

A. One final separation, yes.

X-Q. 360. One operation of separation?

A. No, I don't say that: there is one final separation. I have already called attention to the fact that on page 1, lines 79 and 80, we have a clear statement that the hydro-carbon coated particles float to the surface of the mass, and then we render this separation more complete—I think I am justified in saying that the separation is there indicated as well as later.

X-Q. 361. But it says "in rendering this separation" does it not?

A. Well, it means the separation of the minerals, yes.

X-Q. 362. Now, as a matter of fact your theory tacks on the first part of the second step to the first step, in reading those two paragraphs page 1, commencing line 68 and ending line 87; that is true, is it not?

A. That gives the first and second steps, those two paragraphs.

X-Q. 363. And you tack on the first part of the second paragraph as the tail end of the first paragraph, don't you?

A. We can not connect the two except by stating what you have to start with on the second.

X-Q. 364. Don't you tack those two together as the first step of the process?

A. I use these first two lines of the second paragraph as referring to the results of the first step.

Samuel P. Sadtler

X-Q. 365. Then they are not the first step, but only the result of the first step. Have we advanced that far?

A. Yes, they are the result of the first step.

X-Q. 366. What you regard as the result of the first step?

A. Yes.

X-Q. 367. In that second step we have the result of the first step, and we have the other things which you call supplemental?

A. That is right.

X-Q. 368. And those things all go on together?

A. They all finish together.

X-Q. 369. And the things that you call supplemental are in operation at the same time; it is a continuous operation, is it not, as described here?

A. Oh, you are—you can not talk about the frst step and the second step as being in operation at the same time. There is a sequence, of course.

X-Q. 370. This is a continuous operation, is it not, as described?

A. He says if you use the mixing tank and separation tank, that you can make the operation continuous; otherwise not.

X-Q. 371. The ~~separation~~ specification says that this apparatus may be used continuously?

A. If you use the two tanks.

X-Q. 372. Well, I am referring now to tank 1.

A. Yes, that can be made continuous; that is what the patentee says.

Samuel P. Sadtler

X-Q. 373. Now, we will operate it continuously. In tank A we have agitation?

A. Yes.

X-Q. 374. Or mixing, and nothing else; that is all, isn't it?

A. With its results.

X-Q. 375. We have in that tank—

A. That is the only operation, agitation.

X-Q. 376. In tank B we have separation, have we not?

A. We have first of all a supplementary operation for the raising of additional matter, which we stir up, and the separation of that is the final separation.

X-Q. 377. In tank B we have separation; that is the separating tank?

A. The ultimate separation.

X-Q. 378. That separation is going on continuously, isn't it?

A. Apparently.

X-Q. 379. And in that continuous operation of separation we have the rising of the hydro-carbon coated particles to the surface and the assistance of this hydro-carbon coated particles by the streams of air and streams of oil flowing in at the bottom from the gently rotating agitator arms, isn't that right?

A. That is right, and not as a second operation continuously, but the results of the first operation are passing in, and therefore it is a reinforcing step as I consider it, so that we have the flow passing in and constituting the important operation as I have ob-

Samuel P. Sadtler

served in practising this—the major portion of the operation, and then this causes the rising of the additional entrapped material, which adds to the amount of the floated material, and they together are skimmed off.

X-Q. 380. So you call it a secondary operation because it assists the rising of the hydro-carbon coated particles to the surface.

A. It brings those up which are entrapped. It has nothing to do with what has been done in the first tank.

X-Q. 381. It assists the flotation?

A. It assists the ultimate results, some.

X-Q. 382. It does it at the same time; it is a continuous operation?

A. It can be made continuous according to the author.

X-Q. 383. Well, we have taken it as detailed here, and it is continuous?

A. Yes.

X-Q. 384. You call it secondary, although it takes place in the same vessel and at the same time, is that right?

A. Now, Mr. Williams, you are going back to the same vessel; I have been talking about two vessels, and so have you just now.

X-Q. 385. The separation is what I am talking of.

A. (Laughing.) There is a result from the work of the first vessel which is being passed into the second vessel, which is being supplemented, I say, by

work done in the second vessel, and that work done in the second vessel is what I speak of when I refer to the introduction of air and streams of liquid; that is working in connection with a slow rotation. The other operation is distinct from that operation, and takes place in a distinct vessel; it precedes it in the order of sequence, and the sum total of the two gives the ultimate froth which is taken off by the skimming bar.

X-Q. 386. Although they take place in the same vessel at the same time?

A. No, I don't agree to that.

X-Q. 387. They take place in the same vessel, don't they?

A. They can, but if so there would be two acts; they would be discontinuous in that case.

X-Q. 388. You say they can take place in the same vessel?

A. That is what the author says.

X-Q. 389. There is not a word of description of the separation taking place in any other vessel than the separating tank B?

A. I have said that the ultimate separation takes place in B, yes.

X-Q. 390. And the separation which takes place in B is a separation by buoyancy, suppose we say.

A. We only get the froth after it has been first subjected to agitation. There is no froth separated, but there is the potential froth of the agitated mixture, of course.

X-Q. 391. And it is not separated in that vessel?

Samuel P. Sadtler

A. It does not separate in that vessel.

X-Q. 392. Therefore, if we are to attempt to repeat the Kirby operation we must have in one vessel a separation by the buoyancy of something, assisted by streams of air and streams of oil; that is right, isn't it?

A. If you want to carry through the Kirby operation in full detail as described in the patent you have to do as I say. If you want to prove that the Kirby first step produces a froth, you do not need to trouble yourself about the supplemental steps.

X-Q. 393. You don't need to assist it?

A. You don't need to assist it.

X-Q. 394. Your froth is not in need of assistance, is it?

A. It is not in need of assistance; we had it here produced excellently in the square jar.

THE WITNESS: Mr. Williams, may I still further state my proposition about the two steps, a moment?

MR. WILLIAMS: Yes.

A. I would like to call your attention to the paragraph beginning line 95 on page 1 of this Kirby patent. "It is thought that the use of a gas––of this gas assists in the flotation of the coated particles as set forth in the description of the second step of the process as described." I think that gives us abundant justification for stating as I say that there was a supplemental step which involved this introduction of a gas in the bottom of the separator vessel.

X-Q. 395. Well, we will have to go back to this paragraph commencing on page 1, on line 68. Now.

we have here four paragraphs, and each paragraph sets forth a step, does it not?

A. There are four paragraphs which set forth consecutive steps, as I see it.

X-Q. 396. Now, in the first step and in fact the paragraphs are introduced by the statement that, "The process consists in the following steps"—in the first step we have agitation and whatever happened during agitation? That is right?

A. That is right.

X-Q. 397. In the second step we have separation of the metal or the mineral from the gangue and whatever happens during that separation, that is the second step, isn't it?

A. Yes, but in that second paragraph there are two steps, and as I said the first and second line of that paragraph connect with the first paragraph because that expresses the result of it and then you go on to state the details of the second step.

X-Q. 398. Well, now, isn't it reasonable and logical that a second step, to wit, separation, would be described as a second step even if it were the result of the first step, to-wit, agitation? That is logical, is it not?

A. Yes, but I have frequently just seen this way of statement—have frequently seen just this very thing in connection with the step of a patent, by connecting it with that which preceded it, and that is what was done here.

X-Q. 399. The second step of the Kirby process

as described is separation. That is true, is it not?

A. The second step is—

X-Q. 400. Separation?

A. Is the supplementary treatment for rendering separation substantially complete, it is not separation as expressed under the conditions as stated.

X-Q. 401. Well, where do you put the separation which occurs from allowing the hydrocarbon coated particles to float to the surface of the mass?

A. Now, if you will analyze the last sentence of the second paragraph wherein the separation is compared, that indicates that there are parts of the separation which are to be taken together before completion. Now we have the first part of the separation stated and the result of step one. In the first and second lines they state how this separation is substantially completed or made more effective by doing something else. That is step two, and then the last sentence says when the separation is completed—something they do by agitation and they do by the injection of air—then the floating hydrocarbon concentrate is removed for subsequent treatment. Now, we are ready to take it off by the skimmer.

X-Q. 402. Now, we are ready for the third step of the process?

A. The third step comes in, yes.

X-Q. 403. The second step is separation?

A. In the several stages as described.

X-Q. 404. In that one vessel, separation?

A. Separation is the ultimate result in the second vessel.

X-Q. 405. And when the apparatus is operated continuously that separation produces a float on the surface of that vessel, doesn't it?

A. The float is the final result of the separation which is here described in its several parts.

X-Q. 406. Well, does Kirby describe that flotation as occurring in several steps, or does he describe it as a continuous operation, as one continuous thing? Which is it?

A. He certainly gives the several steps whether you secure them one following the other, or whether it is discontinuous because he says if you want a continuous operation you use the mixer and the separator vessel; if you do it all in one vessel.

X-Q. 407. Now, we will do it in one vessel.

A. If you will just notice the line beginning 114 on page 3: "This separate tank for performing the mixing operation is not necessary for my process, although it is preferable in some cases and where a continuous discharge is desired," and what is the antithesis of that?

X-Q. 408. You read that over before?

A. I know. What is the antithesis of that?

X-Q. 409. I am not answering your questions, doctor. Please answer mine.

A. I was just trying to argue.

X-Q. 410. We will come to the intermittent operation. I have been trying to get you to make a picture of the continuous. Now we will come to intermittent operation. Now, in the intermittent operation what is the first step that takes place?

P. 3730, L. 15, insert " don't wish to make it contin
operation, then you can " after " you "

Samuel P. Sadtler

A. The intermittent operation would take place by doing everything in one vessel.

X-Q. 411. And what is the first step?

A. The first step is a rapid rotation.

X-Q. 412. What is the second step?

A. The second step, following the stopping of the rapid rotation giving time for the result of it, was that you slowly agitate so as to supplement the result of the rapid agitation.

X-Q. 413. Where do you find in this specification that he gives time for results?

A. I will tell you. "The mixing may be performed just as well in a separate tank"—page 3 near the bottom—which may then be termed the mixing in the separate tank. Now, it stands to reason that you can't do both at the same time. Therefore you rotate it rapidly at first and then rotate it slowly when the separation is then made. That means that the ultimate result called the separation is being made or in other words is being supplemented or completed by this slow rising of air bubbles. Then it is slow rotation and the separation is done by the skimming off.

X-Q. 414. Do you find in these specifications any statement that any aeration results from that rapid agitation?

A. Not by name.

X-Q. 415. And the only aeration that you find described there is an aeration which takes place during the gentle agitation by letting in streams of air at the bottom. That is right, isn't it?

Samuel P. Sadtler

A. That is described as the releasing of particles by air bubbles, which you would call aeration probably, but it is not in the sense in which I used the word aeration at first.

X-Q. 416. Now, the purpose of the injection of the gas is described in the specification, is it not? The purpose of the injection of air at the bottom of the separating tank is described in this specification, is it not?

A. That is described particularly at the bottom of page 412, first column.

X-Q. 417. Give the page of the specification?

A. Page 2 of the patent, beginning with lines—well, I will begin in order to include the whole operation, with line 53: "Some of the hydrocarbon coated particles will float to the surface without assistance; but a considerable quantity of such particles will not be sufficiently buoyant and some of such particles and some globules of the mixture would be trapped in the sands." That is the whole object of the second step of the operation.

X-Q. 418. "Globules of the mixture" means globules of oil, doesn't it?

A. Undoubtedly, but it also include air bubbles, must do so, as a result of what we have already done. "In order to recover this less buoyant material together with the globules of the mixture, the mass which tends to settle is slowly lifted and turned over to liberate the coated particles and the globules, and at the same time a gas, preferably air, is blown into the mass

Samuel P. Sadtler

preferably near the bottom thereof." Now, then, follows his description of just what the oil bubbles do in that second step. They bring up the additional particles. But we have third steps as particularly clearly represented on page 1, beginning there at line 95, the fact that this injection of gas is a mere feature, not the main result: "It is thought that a use of a gas to assist in the flotation of the coated particles—"

X-Q. 419. Then it says, does it not, "that the employment of a gas in the manner stated brings in a more powerful floating agency than anything before used, which results in the recovery of this floured oil together with numerous coated particles which would not otherwise be floated." That is a statement of the specifications, is it not?

A. That, connected with what immediately proceeds it; that connected with his talk about the use of his gas step in connection with viscous oils.

X-Q. 420. That is to say, the Elmore process?

A. Yes, that is the Elmore process. That does not refer to this process.

X-Q. 421. Now, doesn't he say at page 2, line 54: "The injection of a gas, preferably air, into the mass which is the chief novel characteristic of the second step of the process, assists in the flotation ~~of the second step of the process, assists in the flotation~~ of the hydrocarbon coated particle." He says that; he says it is the chief novel characteristic of the second step of his process, does he not?

A. What is the line?

X-Q. 422. Line 54, I guess that is it, 54?

A. Yes, I see it.

X-Q. 423. He says that is the chief novel characteristic of the second step of the process, doesn't he?

A. Yes, of the second step of the process, and assists in the flotation.

X-Q. 424. And then when he ~~used~~ said "some of the hydrocarbon-coated particles will float to the surface without assistance" you read that as meaning some of the hydrocarbon-coated particles to which air bubbles have been attached, did you?

A. I did because they are the hydrocarbon particles which already have been taken care of by the first rapid agitation.

X-Q. 425. Now, when you read a description of this float which was taken off in the second vessel, there was one part of that description that you did not read. That commences on page 3, line 55: "The floating concentrates are carried mainly at the lower surface by the hydrocarbon layer where it is in contact with the water." Now, isn't that a description of an oil buoyancy float, by its principal characteristic?

A. I have given that clause a great deal of thought and I have turned farther over to where the same form of statement appears a little fuller on the next page, on page 4 of the patent, where it says in line 20: "Most of the concentrates hang near the contact between the hydro-carbon and water, and as this contact surface becomes over-loaded with concentrates, some of them sink to the bottom of the tank." I think that describes

what we have seen in looking at that square glass cell. It is always observable that there was a gradual dripping away, that dripping away takes place in the case of the air froths quite as obviously as in the case of the overloading of the Elmore solid oil layer. I don't think, from the whole description, that that is necessarily any indication that he had a meaning there of a solid mass of oil or layer of oil when he spoke about the hydrocarbon layer. "Hydrocarbon layer" there means the layer which is just above the water. Now, in my opinion, and I think I am justified in that by studying the matter—in my opinion that hydrocarbon layer there referred to is now an aerated layer from which mineral will slowly drop, and this is there referred to. I cannot connect it with the idea of an Elmore bulk oil result simply because I cannot take the Kirby process and forget the violent agitation. If you could, if you could forget the violent agitation of the Kirby process as the first step then you could work it out very nicely.

X-Q. 426. So you think that the statement that the floating concentrates are carried mainly at the lower surface of the hydrocarbon layer where it is in contact with the water describes a flotation froth carrying mineral particles on the bubbles? Is that right?

A. I think so.

X-Q. 427. And then this second description that illuminated your view, that is of something that takes place in another vessel, isn't it, afterwards?

A. Well, I cannot say whether that is right or not.

Samuel P. Sadtler

Yes. And I think this second description throws light on it because the same feature or the same observation, or the fact that there was a certain dr~~i~~opping away takes place after having spoken of the distinct breaking up by a stirring apparatus of the concentrate froth. Now, the stirring apparatus, 42, described on page 4 of the patent, line 17, the stirring apparatus 42 has its arms revolving gently within this layer so as to break up and discharge the air bubbles, and assist the separation. Then he goes on: "Most of the concentrates hang near the contact between the hydrocarbon and water, and as this ~~constant service~~ contact surface becomes overloaded with concentrates, some of them sink to the bottom of the tank." That is after all the separation is completed, after the so-called skimming has been done, after the concentrates have been washed by passing over water which is moving, in motion, and after that it is desired to break up the concentrate. Now, he stirs them gently to break them up. And, as I understand, most of the concentrates hang near the contact of this froth layer.

X-Q. 428. Oil and water? He don't say "froth layer," he says oil and water?

A. No, I mean out where he commenced there, in the froth layer.

X-Q. 429. You don't think it is a froth still there?

A. I think the froth has not been completely broken up and I will call your attention to line 31: "The concentrates which fall to the bottom of the tank, accompanied by the hydrocarbon which adheres to them, are

Samuel P. Sadtler

drawn off in a thick condition." I consider that an illustration of a frothy mixture; the concentrate is in a thick condition.

X-Q. 430. Read a little further, the two streams—commencing at line 37: "The two streams, one of hydrocarbon and concentrate, the other mainly of water and concentrate, may either be filtered in separate apparatus or united and put through the same apparatus, as is found most convenient." Now, what are those two streams?

A. Well, one is the stream of hydrocarbon, distinguished from that which is here described by the expression "hydrocarbon and concentrates," and the other is the stream of water into which some of the broken down froth has gone, some mineral matter, because the breaking down of the concentrates has been described. And yet, after that description of the breaking down of the concentrates they are described as in a thick condition.

X-Q. 431. As a matter of fact, in this vessel "C" there is a separation, is there not, into two streams, one of which is a stream containing a great deal of oil and the other of which is a stream containing a little oil and water? Is that right?

A. There has been by this time a breaking down and the oil and the water form these two streams, but the description in line 37 to which you called my attention, still illustrates the fact that the concentrates are present carried along in the hydrocarbon layer. There is a hydrocarbon layer now because the froth

Samuel P. Sadtler

has been broken down very largely and I remember Kirby used a large amount of oil. With an amount of oil varying from 25 to 75 percent it is undoubtedly true that when you break down the concentrated layer you would have free oil showing.

X-Q. 432. And you think that that slowly rotating stirring apparatus 42 brings up the froth; is that your idea? And the froth—the metal immediately goes to the bottom?

A. It is stated there to be for the purpose of discharging the air bubbles. That means breaking up the froth.

X-Q. 433. Did you ever see an Elmore float with air bubbles in it?

A. I have seen layers of oil with imperfect frothing conditions and a few bubbles of gas in it.

X-Q. 434. Do you call that an imperfect frothing condition, an Elmore oil buoyancy layer with a few bubbles in it acting like pores in a cork?

A. I do not know where you draw the dividing line. I said "imperfect froth" meaning that the oil was in large excess.

X-Q. 435. What is the next step from the Elmore oil buoyancy layer with a few air bubbles, is it upward or downward?

A. That is just as expressed in the experiment about which we were talking.

X-Q. 436. What is the next step? Tell me. What is the condition that you get?

A. You just want me to describe it?

Samuel P. Sadtler

X-Q. 437. Yes.

A. That is shown in the experiment in which we took 25 per cent of kerosene oil, and first tried the Elmore effect and got quite a little flouring, quite an amount of flouring. The same mixture, without any change whatever, was violently agitated and the whole of it was changed into the aerated froth, so that we changed from one step to the other.

X-Q. 438. Is there an emulsion step in between, oil emulsion step in between?

A. I wouldn't call it so. I would call it an air froth.

X-Q. 439. Is there an oil froth in between?

A. I don't understand the distinction between oil froth and air froth.

X-Q. 440. And you do not recognize the emulsion condition as between the froth and the solid oil?

A. Well, an emulsion of air and oil I call a froth. An emulsion in the pure sense of the word means the commingling of two different immiscible liquids, as in the case of oil and water which, in the presence of certain emulsifying agents can be so thoroughly subdivided that they will not subdivide into layers. That is what we call an emulsion proper.

X-Q. 441. That is a pure emulsion?

A. We have a so-called emulsion by soap and other emulsifiers and other emulsifying agents, as I say—we have a so-called emulsion by soap ~~and water~~ and other emulsifying agents, but to call a mixture of air and oil an emulsion is not quite accurate.

Samuel P. Sadtler

X-Q. 442. Is it possible to have a floating emulsion?

A. Well, I don't know. I suppose there are circumstances under which you could get an emulsion floating on some other liquid.

X-Q. 443. Is cream a floating emulsion?

A. Cream is a floating emulsion.

X-Q. 444. What is the condition of that floating emulsion; what is it made up of?

A. It is made up of the butter fat thoroughly emulsified with the solution of the soluble components of the milk, and kept in emulsion because of the presence of certain protein material which is in the milk.

X-Q. 445. What is the condition of the butter fat in the cream? You say "thoroughly emulsified," but just describe it so that the court can get a picture of it?

A. I haven't studied it strictly or under a microscope so I can't answer that question from that point of view. I would say that the butter fat was thoroughly emulsified in very finely subdivided conditions through the soluble portions of the milk and if you can bring about a coagulation of the butter fat then you begin to break up the emulsion and you get the formation of a more or less clotted condition which ultimately gives us the butter separation.

X-Q. 446. Now, the emulsion condition is a condition in which the oil or fat is ~~so~~ sub divided into very fine particles commingled in a liquid in that emulsion condition?

Samuel P. Sadtler

A. I don't want to pose as an authority on emulsions as some other person could, but these are some of the conditions of an emulsion in the case of a cream.

X-Q. 447. And I suppose you are aware that it is possible to so treat milk that the butter fat globules will be broken up into such fine particles and the emulsion will be so fine that there will be no separation into cream. I presume you are aware of that, are you not?

A. I know that it can be held up for a period of time.

X-Q. 448. That is the condition of homogenized cream, you know that?

A. Yes.

X-Q. 449. Don't you know that can be held up indefinitely by dividing that up into particles of one micron?

A. I am not prepared to say. I don't know.

X-Q. 450. In an air froth or an oil froth, whatever you care to call it, containing metalliferous mineral particles, are the metalliferous mineral particles carried in the lower layer in contact with the water?

A. They are distributed over the whole surface of the film which comprises the froth, but in passing there—but on standing there is very frequent separation from a froth which at first was well defined, with sharp lines, but on standing, just the dropping away that may be ~~seen~~ due to the breaking up of some of these air cells and depositing their load.

Samuel P. Sadtler

X-Q. 451. That is in fact due to the breaking of bu bles, isn't it?

A. That disintegration in some cases—I do know that I have studied the problem of that disi tegration to see just what are the conditions most f vorable for it—but I have observed it frequently.

X-Q. 452. But in a true mineral froth, so long as maintains its stability, the metalliferous mineral pa ticles are distributed all through the froth in the su face of the bubbles? That is right?

A. On the surface of the air cells, yes, sir

X-Q. 453. Now, it is a fact, is it not, that the Kir specification enlarges upon the use of a thin hydr carbon liquid in place of the thick viscid oils used other inventors, as one of the most important featur of his invention. I refer to page 4, commencing wi line 52 of his specification.

A. He says, in line 52, that the advantage of t thin hydro-carbon oil in place of the thick viscid used by other inventors is for one particular reaso He states that the use of the thin oil makes filtrati comparatively easy and permits cheaper methods th the centrifugal machine and the filter process. H contemplates a large amount of oil, from 25 to 75 p cent., and he did not desire to have all of that burned up with the concentrate in the end. He d sired, and in that way he contemplated a recovery the oil ultimately, and filtration is the method he refe to, and with a thin oil it is obvious that filtration more easily practised than with viscid oil, and do

way with the necessity of using centrifugals. That is e feature described in the California Journal Tech-logy as part of the Elmore improved process.

X-Q. 454. And he also speaks of the advantage of ing able to separate practically all the oil by distil-tion?

A. In case of the addition of distillable oil, that is e theory.

X-Q. 455. That is the fourth step of his process, re-rred to on page 1?

A. Yes.

X-Q. 456. The third step being filtration?

A. Yes.

X-Q. 457. The fourth step is distillation?

A. Yes.

X-Q. 458. Have you ever seen the Kirby process in peration as described in the specification, with the nployment of everything that is described in the first ep and the second step, as there described on page 1 the specification?

A. I have never seen the carrying out of the sec-nd step by skimming off with the skimming bar; I ave never seen that practised. I have only practised nd witnessed the operation of the Kirby process in-far as it was desirable to settle the question as to hat was the result of the Kirby process carried rough the first step to see what the result of that as. The supplemental step I never practised.

X-Q. 459. I asked you if you had ever seen carried it everything that is described in the first and second aragraphs, the first and second steps.

A. Not in the second paragraph, no, I have no

X-Q. 460. Did you see that done at the Mian trial in your presence by the plaintiff?

A. I did not see the Kirby process illustrated i that way at all.

X-Q. 461. Did you see the Kirby apparatus oper ated?

A. I don't recall that I saw that process of skim ming.

X-Q. 462. Well, if your recollection was complet you would remember that there was a slowly rotatin skimming bar at the top, which pushed the flowin layer of hydro-carbon, floating particles with a few ai bubbles in it, and that they were collected. Don't yo remember that now?

A. I don't recall the experiment, no.

X-Q. 463. And it was repeated in the Circuit Cour of Appeals in Philadelphia, wasn't it, and you wer there?

A. I didn't see it.

X-Q. 464. You said today that the Wolfe paten which appears in complainant's record in the Hyd case, Vol. 3 page 966, discloses an operation whic necessarily produces a froth, is that right?

A. I said that the operation of what Wolfe de scribes as the rotating turbine, which is otherwise de scribed as the Johnson mixer would necessarily pro duce a froth if rotated with a flowing ore pulp an the oil under the conditions that are shown.

X-Q. 465. That is to say that the sulpho-chlorinat

oil used as it is described in that patent, would over-
ow as a froth; is that your understanding of the dis-
osure of that patent?

A. That disclosure of that patent is that the sul-
io-chlorinated oil, as stated in line 68 and following
page one—the sulpho-chlorinated oil adhering to the
ineral of the ore, floats. Now, that follows after we
ive had the rapid rotation of what he calls the turbine
heel in the mixture of ore and pulp. I have never
perimented myself with the sulpho-chlorinated oil,
erefore I am only judging by my belief of what it is
r, and what purpose it would accomplish. I am also
rengthened in that belief by the testimony of Mr.
ılman that he thought they were efficient baffles, and
at the Johnson mixer was capable of acting as a
ıbstitute in the same way as the Gabbett cone mixer,
ıd then about the description here in the patent of
e circulation, set up in the vessel, I believe that we
ive there a vortex motion which would of course
evelop aeration as the result of the rapid rotation.

X-Q. 466. But I asked what would happen in this
rocess.

A. I don't know what sulpho-chlorinated oil is,—
good oil, or what type of oil it is from any personal
nowledge.

X-Q. 467. You don't know what happens in that
rocess?

A. Not from personal knowledge.

X-Q. 468. Now referring to the testimony of Dr.

Samuel P. Sadtler

Liebmann in the Hyde suit at page 557 volume 2 of complainant's record.

A. I have that.

X-Q. 469. You quoted that, as I understand it, as a description of a normal Froment operation. You certainly applied it to what you regarded as a normal Froment operation, did you not?

A. It is a description of a test tube experiment carried out by Dr. Liebmann, and what his proportions were does not appear clearly. He said, "the amount of carbonic acid which could have been evolved was so small that it would have been dissolved in the water which was present." That was my quotation. I quoted that to call attention to the fact that Dr. Liebmann, as well as myself, recognized what a moderate amount of carbonic acid would be absorbed, and unless there was a very large evolution of carbonic acid and very expeditiously, that we had to consider only the gas which was not dissolved, the excess, in determining how much it would contribute to the air mixture which would form the bubbles.

X-Q. 470. Do you know whether or not that was a description of a normal Froment operation?

A. I think that he presents that as an illustration of what Dr. B~~urns~~ arnes had done in connection with the Froment patent, and he claims that there was an insufficiency of oil in answer to cross question 59.

X-Q. 471. He also said, did he not, that there was a total insufficiency of sulphuric acid—for the purpose of assisting your determination of this matter, if you

will turn to page 555, you will see that this commences with the reference to a certain paragraph in question 34. Do you see that?

A. Yes.

X-Q. 472. Now, if you will turn to page 475 you will see that the paragraph which is following the last paragraph on page 475—You will see that that is the same paragraph; "I took 10 grams of defendant's ore which had been crushed to an 80 mesh, mixed with 30 c.c. of water, and added thereto .036 grams of sulphuric acid (which I had to dilute in order to be able to convey it into the test tube) and 1 drop of cottonseed oil." That is the description of the experiment.

A. Yes, but does that description give you the amount of calcite?

X-Q. 473. If you will follow it up—

A. Because the sulphuric acid and the calcite are the two things that react.

X-Q. 474. If you will turn to defendant's record page 165 you will see on the preceding pages the reference to Dr. B~~urns'~~ yrnes' experiment, and you will find that Dr. B~~urns~~ yrnes was carrying on Froment, not only with insufficient sulphuric acid, but without putting in any calcite.

A. Oh, I see. Well, I can not understand that that experiment was normal, if the calcite was omitted, because the whole feature of my illustration of Froment was to follow Froment's example as given in his Italian patent, in which there was 1 gram of calcite for every 10 grams of ore, and 2 drops of sul-

Samuel P. Sadtler

phuric acid. Now, I calculated that that 2 drops of sulphuric acid could not decompose more than a fraction—more than one-quarter at the outside, of the calcite, and under those circumstances the total amount of carbonic acid gas which could be gotten, without reference to this dissolved in the water, as not more than half of the contents of the tube, and I called attention to Dr. Liebmann's statement there as to the solubility of the carbon dioxide in the water when a moderate amount was produced, as backing up and substantiating my view that the carbonic acid would not play a very large part, and under the increased pressure which for a moment exists when the tube is closed and shaken, you have much more than one atmosphere, and I do not believe that that amount of carbonic acid would do more than start the reaction. In the experiment which I carried out, with very violent agitation for a few moments, there was not a great deal of excess pressure developed at the cork.

Now, these operations to which you refer, when you referred to that testimony of Dr. Liebmann, are representations in the test tube proportions of these experiments described by Dr. ~~Burns~~ ynnes, and also to repeat the Froment British patent?

A. Yes.

X-Q. 475. And in those experiments he took Black Rock ore; he did not put any calcite, and he used one cubic centimeter of sulphuric acid to 492 grams of ore, and 1700 c.c. of water. Now, that was not a Froment operation at all, was it?

Samuel P. Sadtler

A. Well, I could not say that it was; I would have to calculate it out.

X-Q. 476. And you will agree that Dr. Liebmann thought that any carbon dioxide that would be produced under those circumstances would be dissolved in the water and therefore useless in the process, would you not?

A. The 1 c.c. of sulphuric acid would have to act upon the manganese carbonate in the Black Rock ore, and apparently it was not acting enough. I would not, myself, at all, illustrate a—illustrate the Froment experiment that way.

X-Q. 477. Now, referring to the British Froment specification and these words which I think are the same in the British patent as in the Italian—Froment says in the British specification, page 2, commencing line 39: "If the limestone is in excess or readily attackable, the rapidity of the separation is so great that the proper pulp is forcibly projected outside the vessel." Now, you took a proportion of sulphuric acid which could not, by any possibility, have decomposed the limestone that you used, isn't that right?

A. That is correct; it could not have decomposed all of the limestone.

X-Q. 478. Froment gives a certain definite proportion of limestone, doesn't he?

A. He tells you one gram to every ten grams of ore, in the patent, and a few drops of sulphuric acid.

X-Q. 479. So he gives you a definite proportion of limestone, and as you read it, not enough sulphuric

acid to decompose your limestone, and then he tells you that if the limestone is in excess you will get into trouble; isn't that what he says in his specification?

A. That is what he says here, yes; only I didn't get it.

X-Q. 480. When you made your determination with olive oil layers, what were the conditions as to the condition of the water and as to the times that you waited when you got your 9% for the thin layer of olive oil?

A. I took a test tube such as was shown here, of an internal diameter of one inch, and I made the first trial with water at 25° centigrade, which is room temperature, and I dropped the olive oil, without previous warming, at the present temperature also of the room, from a pipette, which was graduated in tenths of a c.c., so I could measure fractions. At .32 of a c.c., or a little over three-tenths, I looked at it from the side, as the test tube was held up, and that gave me very distinctly—more than a thin layer—what I would call a thick layer; but I looked at it from above, and I found that there was not a layer sufficient to cover the water. Therefore I passed on with the trial, and added additional olive oil until I reached .77, or rather more than two-thirds of a c.c., and the layer, which was quite perceptibly thick at the side, was still not in complete contact. I did not jockey it at all by shaking it to spread it out in contact, but I tested the matter fairly.

X-Q. 481. You gave it a good deal of time, didn't you?

A. I went ahead as quickly as I could put it in, and I went on and added further oil, and at one c.c. of this olive oil, dropped in in the same way from above, and looked at, I had a complete covering for the water in this tube; in other words, the layer of oil completely touched the glass all around. Looked at from the side this was more than a thin layer; it was really a thick layer. One c.c. of the oil figures out 8.2% of oil reckoned on 10 grams of ore.

X-Q. 482. And that was the thinnest possible layer that you could get for a covering of the whole surface of the water, wasn't it?

A. At that temperature and in that experiment.

X-Q. 483. Now, you said in your testimony this morning that you had seen a machine made according to the Froment description operated so as to produce a froth. That is right, is it not?

A. In the Froment machine, that is right.

X-Q. 484. That is a machine made according to the Froment description?

A. Yes.

X-Q. 485. Where was that?

A. That was an experiment that was made in the trial at Wilmington, with the Froment machine, and is described in the exhibit book of that trial on page 838 of that exhibit book, volume 4 of the Miami case.

X-Q. 486. Do you remember what the recovery was of that operation?

A. The total zinc extraction by weight was 72.39.

X-Q. 487. That was what you called the power driven Froment machine, wasn't it?

A. It is so called; it was the larger machine. There was a small Froment machine.

X-Q. 488. You had a hand machine there that was just like the Froment experimental apparatus, didn't you?

A. I believe there was also that there in court.

X-Q. 489. And that was operated and it produced a froth, didn't it?

A. I haven't found a record of that. A large number of results were given in what is called the report book, but what I have taken is just those that were accepted in court as shown in the so called assay book. I have seen the small Froment machine operated independent of that trial and assisted at the operation.

X-Q. 490. In the operation of that hand machine which was a reproduction of the Froment experimental apparatus, don't you remember that the first recovery was 2% and the second recovery was 6%?

A. I don't remember anything about it. I have not found the record of the results of the small machine.

X-Q. 491. Turn to exhibit record page 235, and there you will find the assays of those tests and the last one is the first Froment; and there you will find that the recovery as determined by the plaintiff's assayer was 1.95, and the recovery as determined by the defendant's assayer was 2.06?

Samuel P. Sadtler

A. I would like to see that; I don't follow it.

X-Q. 492. Here is the page; volume 4. That is right, is it not?

A. I see the figures which you have quoted, but I don't find that; I don't think it is in my book.

X-Q. 493. This is the transcript—

A. I have found it.

MR. SCOTT: Why don't you ask the witness a question so we can all hear it?

MR. WILLIAMS: The witness was trying to find a reference in the book and I am trying to help him. Have you any objection to that?

MR. SCOTT: Well, let the witness find it.

X-Q. 494. Have you found in this book the figures to which I called your attention?

A. I have found the figures; I don't know to what they refer, because I can not sufficiently identify this experiment with anything which I ever saw. These figures appear in a summary of the assay of those tests. When those tests were made or where they were made or whether I was present, I don't know.

X-Q. 495. Now, if you will take the report book, you have it in your volume?

A. Yes.

X-Q. 496. And turn to page 38.

A. Report book, series C of Froment; here is the small Froment.

X-Q. 497. Now, that is the description of that experiment?

A. With the large Froment machine, yes.

Samuel P. Sadtler

X-Q. 498. Aren't you able to identify what I have shown you as the assay of the result of that experiment; that was the first Froment experiment so described. And then, to refresh your memory still further, I will ask you to turn to Page 236, the next page after the one we had, and take the bottom experiment there, the second Froment series C, No. 6, and the other was series C, No. 6, and there the recovery according to our assay was 4.83, and according to the defendant's assay was 5.29. Don't you now recognize those as the results of that operation?

A. I did not see that operation that I know of. As I understand it, the experiments which were picked out from the assay book and shown to the court are those which were recorded later—picked out from the report book and shown were those enumerated later under the name of assay book, and I did not see all those experiments, and I am not able to say whether I saw either of these experiments with the Froment machine about which we have here the assay results.

X-Q. 499. Now, turn to the assay book page 889 and—

A. Well, I see that, and I see the last paragraph of that page also. We have here a report of two experiments, and the statement is made at the end: "These tests are for observation only in the production of mineral froth, and the apparatus was not designed or adapted for quantitative work, hence the recovery figures signify nothing."

X-Q. 500. How are those recoveries figured there. That is just an argument, and I want the facts.

A. I don't know what they represent.

X-Q. 501. "The extraction, based on the weights aud assays of the concentrates and tailings was 5.66%." That is the second experiment. That was on page 889?

A. That is what is stated.

X-Q. 502. And as to the first experiment, therefore, have you any statement as to what the extraction was. My statement was correct wasn't it?

A. Yes, and the explanation is given below.

X-Q. 503. Now, those experiments that are reported in that book were made in your presence, were they not?

A. If these were repeated in court, then I saw them.

X-Q. 504. And they would not be here in this assay book if they were not repeated in court, would they?

A. I guess that is right and proper.

X-Q. 505. Now, when you testified in the Miami case you had a theory in explanation of flotation did you not?

A. I had at that time stated that the simple selective action of the oil for the mineral as against gangue, and the adhesion of the oil to the mineral and the wetting of the gangue with water was not a broad enough statement, and therefore I discussed somewhat, as far as I knew it, the effect of surface tension. I was very much at a disadvantage in discussing that, for the reason that I am not a physical chemist, and I have never made any experimental

studies or observation of surface tension phenomena, and therefore I only gave my view of the theory as representing the best information that I could obtain on the matter, and I recall that Dr. Liebmann coincided with my views in his similar expression, that it was the broader view of the phenomena, that is, that surface tension was an important feature in determining the question of froth formation. Further than that I did not go. I was in the dark as to the complete theory in the matter, and I remained in the dark until I heard the matter discussed within very recent time.

X-Q. 506. As you then explained the theory of flotation you regarded a reduction of surface tension as essential to flotation, did you not?

A. As essential to the concentration in the film and the development of increased viscosity in the film, which I stated I understood was a result of this lowering of the surface tension.

X-Q. 507. And I believe you very modestly said that you did not regard that as a complete explanation?

A. I certainly said so.

X-Q. 508. You are familiar, are you not, with patent No. 962678, to which you referred in your direct examination and which was put in evidence, that being known as the solution patent.

A. That was the second patent in suit in the previous trial?

X-Q. 509. Yes.

A. Yes, I familiarized myself with this patent.

X-Q. 510. In fact you made a careful study of it and testified about it in the Miami suit; that is true, is it not?

A. I testified about it at that time.

X-Q. 511. And gave it careful study?

A. I did.

X-Q. 512. This patent discloses, does it not, a process of concentrating ores which consist in mixing the powdered ore with water containing in solution a small quantity of a mineral frothing agent; agitating the mixture to form a froth, and separating the froth?

A. That is stated in the claim to be the process.

X-Q. 513. That is disclosed in this patent, is it not?

A. Well, when you ask my opinion about that I can not answer that categorically, because I would have to refer to the fact that mixtures containing soluble portions which are in themselves frothing agents, are described, as already testified to; and when I analyzed this patent at Wilmington I referred to the prior reference to such soluble frothing agents in the Cattermole patent, cresol and phenol for instance.

X-Q. 514. I limited the question to what this long document disclosed, and I read the language to summarize it. That is my question; not whether it is the first disclosure or whether it is a proper claim, but whether or not what I read to you is disclosed in that patent.

MR. SCOTT: I object to that question your honor. It apparently has no relevancy in this case. It is ab-

solutely incompetent as to what some patent means that we have neither set up in anticipation and which in fact is here and which is not involved in this suit.

THE COURT: Didn't you introduce this in his testimony in chief?

MR. SCOTT: Some slight reference was made to it for some purpose that I have forgotten.

THE COURT: At any rate, this man is an expert. It may even go to test his knowledge. I hope there will not be too much of it. The objection will be overruled.

A. I think this is disclosed as I stated it.

MR. WILLIAMS: If your honor please, I have a few notes which I can not put my hands on at the moment because the witness finished earlier than I thought he would, and I will finish up the cross examination very early in the morning.

Whereupon an adjournment was taken until tomorrow morning, Friday, May 4th, 1917, at 10 o'clock a. m.

Friday, May 4th, 1917, 10 A. M.

MR. KREMER: If your honor please, the order in connection with the filing of the amended and supplemental bill gave us—I think the order reads until Saturday in which to file the answer. I have the answer dictated, and it is practically completed; I think I will be able to file it today; however, I wanted to inquire as to whether or not the order included Sat-

urday. I have engrossed or embodied the answer to all of the amendments to the complaint, so that there will be just one pleading in that respect and one pleading to the supplemental answer, so it really necessitated two pleadings.

THE COURT: Proceed with the examination.

DR. SADTLER,

CROSS-EXAMINATION resumed,

BY MR. WILLIAMS:

X-Q. 515. When was your attention first called to the California Journal of Technology; I mean, of course, the article therein which was introduced in evidence.

A. I think it was probably about the end of 1914, some months before the Miami trial.

X-Q. 516. Just before the Miami trial?

A. Not just before, but some months before.

X-Q. 517. You remember, of course, that it was called to the attention of the plaintiff just before the beginning of that trial, when we had all gathered at Wilmington and were ready to start with it; that was the first knowledge you had of it, at the time of the trial?

A. Well, that was not quite the first, because I had been told of it some little time before, and I went to the library in Philadelphia, of the Franklin Institute, and looked up the original Journal which was there on file, and I had photostadt copies made of it some little time before the trial.

Samuel P. Sadtler

X-Q. 518. Now, comparing the Kirby process as you understand it with the Froment process as you understand it, they are essentially the same in their froth formations, are they not?

A. They involved in both cases the formation of an agitation froth by analogous devices. The conditions are considerably different in some respects The Froment process, as carried out on the larger scale and as described in the Froment description, uses relatively small quantities of oil, as stated in the Froment description, 1% of oil for ore containing 5% of metal, 1½% of oil for ore containing 10% of metal and 2% of oil for ore containing 15% of metal. On the other hand, in the Kirby process we have a different kind of frothing agent, namely the light kerosene, or a solution of bitumen in kerosene, and it is used in a relatively much larger amount; but I find no difference in the result, looked at as a principle. In either case there is a complete froth formation, which froth becomes mineral-laden, whether the amount is 25 to 75% of Kirby or whether it is the smaller amount of Froment, and that takes place in the Froment procedure also in a so-called mixing device in which there is a centrifugal mixing device and from there it passes to the so-called coil-vat; in that respect there is a close analogy.

X-Q. 519. Now, comparing the Froment patent, British and Italian?

A. The Froment patent is a simple description of

a principle illustrated by an example, and we have there nothing more than an illustration of the independent formation of an air froth by agitation, aided in this case by the presence of the carbon dioxide which is evolved in whatever degree it may be, due to the reaction of the sulphuric acid and the calcite. But the Froment example and the phenomena observed by Froment, and made the basis of his patent, are simply illustrations of the principles and the broad results which follow. We have to turn to the Froment description, of course, for working apparatus, if that is desired.

X-Q. 520. According to the Froment principles, as you understand them, the froth is composed of air bubbles with a coating of sulphide or metalliferous mineral. That is right?

A. Mineral and mixed gases.

X-Q. 521. And according to the Kirby process as you understand the froth is composed of air bubble with a ~~bubble~~ coating of metalliferous minerals?

A. I think so. I so conceive it.

X-Q. 522. Well, that is true.

A. I do so conceive it to be true, yes. That is what I meant to have said.

X-Q. 523. Now, will you turn to the file, wrapper and contents of the Kirby patent, Hyde record, defendant's record page 517 and at the top of page 517 you note that the claim 2 was rejected by the patent office on Elmore, Sulman and the British patent 12,778 to Lake?

Samuel P. Sadtler

A. Claim 3 you speak of?

X-Q. 524. Claim 2? That is true, is it not?

A. The claim 2 which was rejected, does not speak—

X-Q. 525. Just answer the question, please?

A. Claim 2 was rejected by the patent office in view of those patents named by you.

X-Q. 526. And one of these is the Froment British patent?

A. That is true.

X-Q. 527. Now, claim 2 which was rejected appears at page 510 and is as follows: "The process of separating minerals, which consists in mixing together pulverized mineral material, a considerable quantity of water and a substance emissible in water but of less specific gravity, and which, in the presence of water, will adhere to some of the mineral particles and not to others; in gently agitating the mass and blowing into the same a gas to assist the flotation of said immiscible substance and the mineral particles which have become coated therewith; in removing the floating layer and separating said adhering substances from said mineral particles, substantially as specified." That is right, is it not?

A. That is a correct reading, yes, sir.

X-Q. 528. Now, we will turn to page 526, and there we find, do we not, the arguments that were submitted on behalf of the applicant as to the rejection of that claim 2 on the Froment and other patents? That is right?

Samuel P. Sadtler

A. There is an argument here and I am just beginning to read the portion—

X-Q. 529. Now, I will read a part in that argument, commencing about the middle of page 520: "Lake's process"—that is the Froment British patent, is it not?

A. That refers to the British patent agent, I have no doubt.

X-Q. 530. And in whose name the Froment patent was issued?

A. Yes, sir.

X-Q. 531. "Lake's process is for a specifically different thing, and does not tell the public anything about the advantage of gently agitating a mixture of water and mineral particles coated with an immiscible liquid and assisting their separation by blowing in air." Now, I will say here that there are some typographical errors in the print which will appear upon a comparison with the original file wrapper and contents and I am reading it with the corrections. "Lake discovered that gas bubbles liberated in mineral which he describes become coated with chalcopyrite dust. This discovery is absolutely without value in the applicant's process since the mineral particles are already coated with bitumen, and the problem presented is one of separating the bitumen from the water." Do you agree with the statement made on behalf of Kirby in the prosecution of his application for a patent, that the discovery that gas bubbles become coated with a dust

Samuel P. Sadtler

of metalliferous mineral is absolutely without value in the Kirby process?

A. No, I do not agree with that. I agree with the first part of what you read that the Lake process is for a different process from gently agitating. I agree with that, and I do not agree with the idea that gas bubbles in the Kirby process may be coated with chalcopyrite dust, as it is termed, simply because we have the several elements in the separated froth. We have the coating that he speaks of with bitumen, but that bitumin is a solution in the thin kerosene and constitutes the oil film. Now the oil film concentrates in itself the chalcopyrite dust or the other mineral particles and we can have the coating which is referred to here by the attorney for Kirby, and we can also have the separating in that film of the mineral particles, and do have it.

X-Q. 532. You do not agree there with the statement?

A. I do not agree with the statement as it is given here without qualification.

ing some gas coated with metalliferous particles are

X-Q. 533. And you believe that bubbles contain-clearly disclosed in the Kirby patent? That is what you believe?

A. That bubbles coated with oil films of the character of the oil used by Kirby, that take up the load of metalliferous mineral, and that forms the strong coating of the bubble and enables it to give us the concentration.

Samuel P. Sadtler

X-Q. 534. Doctor, turn to page 510. I will read to you claim 1 of Kirby.

"The process of separating minerals, which consists in the mixing together (a) pulverized mineral material (b) a considerable quantity of water (c) a substance immiscible in water, but of less specific gravity, but which, in the presence of water will adhere to some of the mineral particles and not to others; in removing from the surface of the mass the floating immiscible substance and the mineral particles to which it is adhered; in the filtering the material so removed, and in distilling the filtrate to drive off and recover such immiscible substance, substantially as specified." Do you agree with that statement of Kirby's invention as he originally filed it in the Patent Office?

A. That is a distinctly different statement, less complete than now appears in the first claim of Kirby's patent as issued. At the same time I call your attention to the fact that what is here stated allows our understanding of a froth formation and float, for the reason that we have in here these words, "in removing from the surface of the mass the floating immiscible substance and the mineral particles to which it has adhered." Now, it was quite conceded in the course of the discussion of the Elmore patent that the Elmore separation of the mineral particles did not take place in the surface of the Elmore oil layer. Here we have the separation of the floating immiscible sub-

stance and the mineral particles ~~form~~ form the surface of the mass, which means a froth; but it was more elaborated and more clearly stated in the final form in which the Kirby patent was issued.

X-Q. 535. Isn't it an essential feature of every process wherein they float the metalliferous particles to the surface that they separate that float in order to get the mineral particles away from the gangue which is in the pulp?

A. Of course you separate the mineral particles that have been taken into the oil, but there are two conditions existing; the one case in which the float in the form of a froth is on the surface of the oil, and the other case as in the Elmore process, where it is carried by buoyancy throughout the oil layer, and the separation takes place, not from the surface, but takes place by means which have been described in the California Journal of Technology, by centrifugal or other means of that type, in which they get a perfect separation of the whole mass of the oil layer with the mineral.

X-Q. 536. I will read the question. (Last question read.)

A. I can answer yes, to that.

X-Q. 537. And isn't it a very good description of that operation, if we say "removing from the surface of the mass the floating immiscible substance and the mineral particles to which it has adhered."?

A. It is a good description if we apply it to the

removal of the froth. It is not a good description if we apply it to the separation involved in the Elmore process.

X-Q. 538. The Elmore process, does not the floating layer of oil carrying mineral particles overflow so that by that overflow it is removed from the surface of the mass of the pulp; answer directly, please.

A. They are carried undoubtedly in the oil layer, but not on the surface.

X-Q. 539. Isn't the oil layer carried on the surface of the pulp until it is overflowed or removed from the surface of the pulp?

A. Yes, it is

X-Q. 540. Now, in the Froment description at page 733, of complainant's record, Volume 3, in the Hyde case—

A. I have the whole translation of Froment here, although I do not follow your paging.

MR. SCOTT: I will give it to you Doctor. Here is page 733.

X-Q. 541. Under the heading "Instructions," is it not stated that "in order to arrive at a perfect disintegration of the constituent particles of the ore, without rendering it impalpable, it is necessary to do the crushing in two operations," and is it not further stated that "on leaving the second crushing mill, the ore will further be submitted to two or three spitzkastens for eliminating the slimes, which is too fine to be treated, and which could not be treated by any hitherto known

method." That is the statement of Froment's description, is it not?

A. That is the statement.

X-Q. 542. And that is an instruction, is it not, to deslime the material that is treated?

A. That is what it practically amounts to.

X-Q. 543. And in all these experiments which you have referred to or which were conducted at the Miami trial, it is true, that the ore was not de-slimed, and you so admitted, did you not?

A. I don't recall the condition of the ore when we used the Froment apparatus, large or small machine. There is no such limitation, of course, in the Froment patents, Italian or British.

X-Q. 544. I did not ask you that; please confine yourself to the question.

A. I don't recall in regard to the separation of the ore for the Froment machine, because I had nothing to do with the preparation of the ore.

X-Q. 545. You don't remember that you admitted that that ore was not deslimed?

A. I don't remember that I admitted it, because I had nothing to do with the preparation of it. If I did admit it, it was because I was told so by hearsay.

X-Q. 546. Is there in the Froment patents Italian or British, any mention of the use of heat or of heating the pulp; answer directly, please.

A. I believe not.

X-Q. 547. You know there is not?

Samuel P. Sadtler

A. I don't remember—Yes, I know there is not any iention of the matter of temperature.

X-Q. 548. Now, we will turn to the record in the Iiami case, Volume 2, page 1004. To make the mater as short as possible, it appears on the preceding age and on this page, does it not, that you summed p the question of the bearing of surface tension on re concentration and stated three cases were to be onsidered; first, the normal surface tension of the ater; second, where the surface tension of the waer was raised, and third, where the surface tension f the water was lowered. That is true, is it not?

A. That is the classification under the head of the earing of surface tension on ore concentration; there vere three cases, as you stated.

X-Q. 549. Now, I will read to you what you said bout the third case, from page 1004: "Now, third. n the third case the surface tension of the water may e lowered by dissolving certain organic compounds or ontaminating or so called modifying agents. This hird class includes all agitation and aeration processes vhich are dependent upon frothing or bubble formaion, whereby the buoyancy of the air becomes effectve for raising minerals. And as I have already inlicated in the matter which I read, this would include he effect of emulsif~~ying~~ied oil in lowering the surface ension either by soluble or insoluble contaminating gents—lowering the surface tension and thereby acilitating froth rising." I have read your evidence orrectly, have I not?

Samuel P. Sadtler

A. Yes, sir.

X-Q. 550. Now we will turn to page 1162, and I will start with X-Q. 1238. "Q. What is your idea of what an oil froth is—I don't quite understand it. A. The word is used a little indiscriminately. Sometimes the oil emulsion is called oil froth, because sometimes an emulsified effect is sometimes referred to as froth, but as the word froth is more particularly used in reference to these processes, I must differentiate between oil emulsion and oil formed froth, which I am trying to do. X-Q. 1239. What is oil emulsion? A. It is an emulsified mixture of oil and some aqueous liquid, in which the air plays a very secondary effect. X-Q. 1240. What are the bubbles made of—They are air? A. Probably air." I have correctly read your testimony, have I not?

A. You have.

X-Q. 551. We will turn to page 1170: "X-Q. 1304. Do you put forward, as an explanation of the phenomenon of a mineral froth produced by agitation or produced, as you have said, the doctrine of surface tension as a complete explanation of the phenomenon? A. It explains the case of soluble agents, as probably the only scientific explanation, because we can not assume there that those dilute solutions of the frothing agent have the selective coating action which is ascribed to oil. It can also be made to cover the case of oil used in small quantities, because by the use of oil in small quantities, we have present the emulsification of the oil, and the oil emulsion there acts distinctly in

Samuel P. Sadtler

ne way of lowering surface tension, as is stated by nese authorities which I have quoted. So that it is road enough to cover both oil used in small amount nd the use of soluble frothing agents, and it makes unnecessary to dwell particularly upon the selective ction of oil, which of course exists for mineral parcles." Have I correctly read your testimony?

A. You have correctly read what I said at that me.

X-Q. 552. We will turn to page 1181, commencng with R-Q. 1365. "Q. Upon your previous exmination you discussed the theories underlying the ormation of froth, and referred to the early theory f the selective affinity of oil, and then went on to say: am inclined to believe that at the present time the eneral view is that with the flotation processes which se small quantities of oil there is a broader explanaon.' I want to ask you whether that broader exlanation is confined to the use of small quantities of il, or includes all cases in which a froth is formed; nat is, by a small quantity of oil, referring to that erm in the sense in which it is used in Patent 835120. . I had in mind there the thought that particularly hen small quantities of oil would be used, that the il would be easily emulsified, and we would then ave that condition of oil emulsion which it is stated as the same influence in the way of lowering surace tension that the soluble frothing agent has, or oluble contaminating agent. But if the oil be in somehat larger amount, it is only a question of its

emulsification. A portion of it is always emulsified with the energetic agitation which is carried out in these processes for air froth raising. The presence of a trifling amount of unemulsified oil would not interfere, as I could see, with that way of operating, and I think that, until the oil amounts to a considerable amount, that it will be emulsified sooner or later in the continuance of that first stage of operation; that is, the agitation; and there will be enough of it emulsified very promptly to make it possible to include it in this explanation, or this underlying theory that I spoke of." Have I correctly read your testimony?

A. You have correctly read what I said.

X-Q. 553. Now, we will turn to page 1331, commencing with Q. 34a. "Now, Doctor, I think if you will take the rest of the session and describe the operations which were performed and the results, it will assist in understanding this matter. A. In this last experiment, the oil taken was chosen so as to typify the thick viscous oil of the Elmore process, but taken in the amount of 25% which is utterly inadequate to effect the desired flotation by the buoyancy effect alone, which has been stated by witnesses repeatedly, requires the use of 100 volumes, or 100% to realize the bulk oil flotation. Nevertheless, this was given careful and slow rotation, which would correspond to the Elmore mixing treatment, and we then examined the oil layer, and it was found to be broken, and the oil globules had dropped out because of the overloading with mineral, and quite an amount of these oil

Samuel P. Sadtler

globules gathered below. The mixture, after a short time for observation, was then shaken vigorously for a few minutes, and we then had an air froth formed, although the air froth did not illustrate a very perfect separation, because of the character of the oil and the large amount. Q. 34 b. The residuum oil—Is that suitable for the formation of an air froth, a mineralized air froth? A. No. sir, it is not." Have I correctly read your testimony?

A. You have.

X-Q. 554. We will turn now to page 2085, which is in volume 3 and I will commence with the answer to question 29, with the general statement that the—well, I will commence with the question so as to make it clear: "In scenes 20 to 44, a series of pictures was projected, showing the current of air bubbles, passing through a water clear, and water modified with different reagents—different substances.

What comments do you have to make upon the experiments shown in those pictures?

"A. These were very interesting illustrations, and, essentially, they illustrated very well what already had been shown in the circular aeration cell which I have shown in my testimony. We found the same thing practically by modifying water, first starting with pure water and seeing the formation of air bubbles in pure water, and then adding a single drop of cre~~o~~sol, and seeing the effect of that, producing the breaking up of the larger bubbles into fine air bubbles, a condition that forms, momentarily, the white ~~black~~ish layer of finely

divided air bubbles due to the modifying of the cresol.

The pictures of Dr. Grosvenor show the matter very clearly and ~~suitably~~, and better perhaps than the single operation, because it was possible to follow the condition and compare more graphically, I should say, this condition than by watching the single experiment. I have to say, generally, I agree entirely with the statement:

'Agitation of water unmodified by a mineral frothing agent produces air bubbles which coalesce, rise and burst. Mineral frothing agents produce small and persistent air bubbles.'

"I believe that is well known." Have I correctly read your testimony?

A. You have. I would like to say that the text is hardly accurate there. Referring to the pictures of Dr. Grosvenor, the expression is: "Due to the modification of the cresol." It should be due to the modifying effects of the cresol, but you have given it correctly as it appears here.

X-Q. 555. Now, page 2092, commencing in the second paragraph of the answer to question 45: "Now we had two experiments, of which the second one only need to be carried out, using light pine oil which is insoluble oil, and will be taken in the amount of three per cent, reckoned on the water taken. With that we had meant to compare the effect of .1 per cent. What will be produced here will be an oil emulsion, or rather, an emulsified oil, I would prefer to call it,

Samuel P. Sadtler

which is a froth raising agent." Then, passing down to question 46, thereby omitting the statements of counsel: "Are you going to do the experiment first with the small or with the large quantity of oil? A. First with the small quantity. We have here the effect of a modifying agent, although not a soluble modifying agent. Emulsified pine oil has the same effect of lowering the surface tension, which is the end to be achieved by the soluble frothing agent, and the froth produced may be a little more lasting. (The experiment referred to was performed). This is with an insoluble agent." Have I correctly read your testimony?

A. That is correctly read, and it is what I said then. I thought so then.

X-Q. 556. Continuing on page 2093, question 49: "In connection with scenes 46 and 47, Doctor Sadtler, I notice that Dr. Grosvenor prefaces his remarks by the statement: 'Practical results—air bubbles produced in modified water pick out metallic particles and reject gangue particles', which statement he discusses in the following part of his testimony. Are you in agreement with the con~~dit~~clusions there drawn? A. I think this is correctly stated.

X-Q. 557: "Q. What relation has this phenomenon to flotation concentration generally?

"A. This is, as stated, an expression of practical results, and I think it is undoubtedly true that flotation phenomena are those produced by the air bubbles, and the qualified expression, 'in modified water' covers a

number of cases in which the water is modified, either by the presence of emulsified oil or by the presence of soluble frothing agents, both of which have a general effect of modifying the water and making it possible to obtain more permanent subdivision of air bubbles, which facilitates, and is the underlying explanation of the reason of the mineral froth." Have I correctly read your testimony?

A. You have.

X-Q. 558. Now, we will turn to page 2099 and I will commence to read in your answer to question 71: "The air froths undoubtedly consists of metallic particles which are held and brought up to the surface of the froth by the action of air bubbles, and it is the air bubbles which attach.

"Now, we have a demonstration in those experiments in the glass cell, that the air bubble attaches equally to the unoiled and to the oiled particles of mineral sulphide, so the direct attachment is to be obtained in the application to oiled or unoiled particles. It is not confined to the unoiled particles. It is true there is no entrainment of oil. It is true, but the presence of oil is none the less to be shown, and has been shown in these experiments, which were made in the glass jar, and that is practically allowed for in the last sentence of this statement: 'Fundamental principles air entrainment and controlled affinity of air for metallic particles in presence of frothing agents.' That 'controlled affinity of air' will cover the case of air froth in which notable quantities of oil are used, because it is the pres-

Samuel P. Sadtler

ence of the emulsified oil which makes possible, as the modifying agent, that air rising, and not only is that true, but I am satisfied that the presence of oil in the large number of these air flotation processes operates not only to make an emulsion, which makes lower surface tension, but operates in minute amount in oiling the mineral particles, and that the raising of the air bubble is the raising of the oiled mineral particle." Have I correctly read your testimony?

A. You have correctly read what I said at that time.

X-Q. 559. You remember, do you not, that during the Miami trial an experiment was made in behalf of the plaintiff using one tenth of one per cent of oleic acid and producing a fine mineral froth and then 3.6 per cent of oleic acid was added, the operation repeated, and everything sank to the bottom. You remember that experiment?

A. What was the latter part of your statement?

X-Q. 560. 3.6 per cent of oleic acid was added to the pulp, the operation was repeated ~~and~~ agitat~~ed~~ion for five minutes, and at the conclusion of that operation when the material came to rest, everything went to the bottom. Do you remember that?

A. I don't recall the details.

X-Q. 561. You don't remember that experiment?

A. I don't remember the experiment now. I would not feel sure that I remember at all that that was done. It may have been true, however, that that was done. I don't recall it.

Samuel P. Sadtler

X-Q. 562. Now we will turn to the Everson patent, page 607 of the Hyde record and to page 2 of the Everson patent and I call your attention particularly to the sentence beginning on line 105: "Devices and methods now well known in ~~the water~~ wet separation of ores will be suited to this part of the operation, bearing in mind that the sand and mineral are merely transposed or their relative positions are reversed, because the sand is heavier than the mixture of mineral, oil and acid." Then the following sentence: "A proper selection of devices for this purpose will be apparent to those skilled in the ~~water~~ wet separation of ores." Now, do you know what devices were referred to by Mrs. Everson in this patent of hers issued in 1886 as "devices well known" in the United States in the wet separation of ores? Answer directly?

A. Speaking from general knowledge which I acquired of this matter I would say the spitzkasten was perfectly well known. I am not a metallurgical engineer and I might possibly be more specific in my statements had I knowledge acquired from study of the literature on ore dressing; but the spitzkasten was perfectly well known as has been shown by the testimony introduced, that it was known and known by name prior to 1885; and this description here fits perfectly with the possible use of a spitzkasten. So that if it was well known, we have there undoubtedly a form of apparatus which would do exactly what was desired here, carry off the float, leaving the sand separated. And this particular note of Mrs. Everson's,

Samuel P. Sadtler

"bearing in mind that the sand and mineral are merely transposed or the relative positions are reversed, because the sand is heavier than the mixture of oil, ore and acid." That fits perfectly with the use of a spitzkasten. The sand is settled down, is taken off at the bottom and the froth, composed of these ingredients, that is the mineral and oil in presence of acid, by agitation worked into a froth, is carried off, floated off.

X-Q. 563. Do you know that any such procedure would be in accordance with the established principles and methods of wet concentration as carried on in 18~~6~~86?

A. I do not know it in a professional sense because I have no knowledge that is at all accurate of metallurgical practice.

X-Q. 564. Now, returning to the Miami record, to refresh your recollection as to that experiment, which you did not remember, turning to page 2130—

A. Of what volume?

X-Q. 565. Volume 3. I will ask you to look at the details of that experiment entitled "Second experiment, showing air bubble rejection of well oiled particles"?

MR. SCOTT: What is the question? Is there a question on the record?

MR. WILLIAMS: I wanted to give the doctor a chance to read that before I finished the question.

X-Q. 566. Have you examined the description of that experiment?

A. I have.

X-Q. 567. Isn't that the experiment to which I referred?

A. That is the experiment evidently to which you referred. I have no recollection at the present time of the conditions of the manipulation. I undoubtedly was present in court but I do not recall the conditions of the manipulation and I cannot pass a critical judgment on the result without that illustration of the condition of agitation and other processes.

X-Q. 568. The experiment was made in your presence?

A. I presume it was but I do not recall it.

MR. WILLIAMS: Cross examination closed.

RE-DIRECT EXAMINATION,

BY MR. SCOTT:

R-Q. 569. Doctor, you referred to the passage at page 1081 of the Miami record, volume 2, the passage which was read to you, and I will ask you if you have any desire to make any comment upon the statements you there made?

A. I said at the time of the Wilmington trial in answer to cross question 671, the question being: "And is not associated with directons representing any definite mechanical structure? A. There are none." I would like to say now that I did not do justice at that time to the Fryer Hill publication. The Fryer Hill publication, if studied very carefully, and it has been

Samuel P. Sadtler

illustrated here of course by the apparatus, and I would like to say now that there are very definite directions with regard to the mechanical structure. In other words, the whole story which we find in the Fryer Hill publication in regard to the circular tank, or receiver, the rotating, hollow tube, the bottom of which tube having attached to it a couple of fans and the whole operation of this, the semicircular doors which are attached, hanging vertically at the beginning, afterwards raised, shows quite a definite statement of mechanical structure. In other words, the mechanical structure was quite sufficient and complete there to allow the reproduction of the Fryer Hill device; and that has been reproduced and operated, based entirely upon that information.

R-Q. 570. A passage was read to you from your testimony in the Miami case occurring on pages 1059 and 1060, and in that connection will you state whether Everson disclosed more than one method of concentrating ores?

A. This method which is under discussion and consideration, to which the questions and answers were given on page 1059, had entire reference in that first instance or first illustration of Everson with regard to the mixing of acid with oil and then after that mixture had been made completely, working up the ore—that mixture had been made complete, working up the ore; and that was specified to be a process of washing out the gangue; and the quantities there

given show that it was a process for eliminating the gangue and leaving in a pasty mass the supported mineral. That process I have characterized in my testimony in this case as a different process from the froth raising process and not involving froth raising. And I have illustrated in this case the second form or second process of Everson in which petroleum or a petroleum particle was used, and in which the Fryer Hill apparatus was made use of and also the cataract machine was availed of to illustrate the second step of the Everson process, quite different. And in the beginning of my testimony in this trial I endeavored to classify the processes of operation and in that classification I put the first instances of Everson and second instance of Everson in totally different categories.

R-Q. ~~8~~571. A passage was read from your testimony in the Minerals Separation v. Miami, the passage relating to the Criley and Everson publication which appears on page 1083, volume 2, of the record in this case. In connection therewith I would ask you what if any inference you draw or obtain to base upon the use of the word "scum" in that Criley and Everson publication?

A. The Criley and Everson publication, as I have also in connection with testimony in this case mentioned, contribute only a picture of results of the account given in the Fryer Hill publication. That picture of result is—or rather it contributes merely a picture of result with continuous methods because it gives so little account of the general sequence of steps.

Samuel P. Sadtler.

But then, it says, "This acidulated water was then mixed with the mass of oil and ore. A thick scum of sulphurets rose to the surface and was skimmed off leaving the hitherto black ore as white as snow." I have heretofore illustrated that the word "scum" was synonymous with "froth" and I have also drawn attention several times to the fact that the words "froth" and "scum" are constantly used as synonomous in the literature of these patents, and particularly in the patents of the plaintiffs.

R-Q. 572. You have referred to the use in the Kirby patent of a solution of bitumen and kerosene. Does Kirby refer to the use of anything else besides this mixture?

A. Yes. In Kirby's patent we have the statement on page 2 of the patent: "Kerosene alone, for example, may be used with most ores to take out the sulphides, provided the gas is used as stated to cause the flotation of the kerosene particle." That means that you can use kerosene if you supplement it with the use of a gas as is described by him in detail here on the page preceding; but, on the other hand, he says it is the bitumen which, dissolved in the kerosene, gives the decided adhesion to enable him to separate the pulverized chalcopyrite. And therefore, as I understand it, he meant to say that if this bitumen in small amount is dissolved in kerosene you have a distinctly more efficient frothing agent and selective agent, if it can be called; but if you supplement the use of kerosene taken alone by the use of a gas as in the second step, you

Samuel P. Sadtler

need not use the bitumen, you can use the kerosene without dissolving the bitumen. I have tried both ways. I have used kerosene repeatedly in the Kirby experiment and I have used a certain Trinidad asphalt, a type of bitumen, in the amount there mentioned, five per cent with kerosene, and attained results in both cases.

R-Q. 573. A number of passages in your testimony in the case of Minerals Separation vs. Miami were read to you. Do you desire to comment upon any of the matters there presented? The first one was on page 1170, X-Q. 1104. Was there any explanation or comment you wish to make? If so, you will be given an opportunity to discuss it if you want to?

A. I do not care to go into the details of the question about the surface tension. I would merely say that what I stated there is very much less of an explanation—a very much less perfect understanding of the physical phenomena than we have arrived at now. Undoubtedly the effect of surface tension exactly as stated there exists, but the way in which lowering of surface tension is followed by the strengthening of the film once produced by the increased viscosity given to it under the conditions of practical working has been more fully developed since the date of that Miami trial; and ~~any~~ my explanation given there I would not consider as at all a full explanation of the theory. The theory has been dealt with very fully in this trial and I have a clearer view now of what takes place in the formation of a mineralized air froth than I had

Samuel P. Sadtler

then, although I do not feel that I made a gross misstatement at that time.

R-Q. 574. You have heard the testimony given about the operations of various films using quantities of oil ranging upward—I think the highest so far was the Arthur plant of the Utah Copper Company where something like 86 pounds of new oil were added per ton of ore. Will you compare such operations with the processes described in the Everson patent and the Kirby patent and the California Journal of Technology?

A. These processes involve as the same step mentioned in all of these publications, the thorough agitation. Now, the thorough agitation is one very deciding element in the determination as to the amount of oil used in an operation. In other words, the necessary amount of oil to produce a mineral-coated froth is a function of several elements, one of which is this agitation. Agitation being one; the richness in mineral sulphides being another; and the dilution of pulp being the third. Particularly in the case of—particularly on the question of agitation I would like to say that if we provide sufficient agitation the large amount of oil can be entirely handled, entirely brought into the condition of a coating film of the additional air bubble supply, and that oil coated film then, as the next step, condenses on its surface the mineral sulphides, strengthening the film, making it more stable because of the increased viscosity. And this takes place with the small amount of oil or with the large amount of oil, the main deciding function (factor) there being in-

creased agitation. So that, in principle, it is not different from what was done with 17 per cent of oil in Everson or with the nine per cent of oil I tried in the Froment test tube experiment, or with the smaller amount of oil used in the Froment machine or with the 25 per cent of oil used in the Kirby. In all cases, if we provided the agitation, we accomplished the production of the oiled air bubbles which constitute the froth. These, as I say in turn are stabiliz~~z~~ed and give us the mineralized froth, which is the new product in all cases.

R-Q. 575. It has been testified, as I think you remember, that the agitation was not at all altered when these large quantities of oil were used. How do you explain that?

A. The agitation is quite abundant in all of the operations that I have seen here to accomplish the formation of a froth which takes up all of the oil in the form of oil film, and I don't know in what degree agitation is controlled or modified to respond to different amounts of oil in large practice; but as far as I have seen illustrated in the illustrating experiments there was no difficulty at all in handling 25%—the 25% of Kirby or the amounts that were used in the Everson with the ordinary agitation there shown.

R-Q. 576. Did you see the experiment performed by Mr. Dosenbach in which he used something over 1% of oil and agitated the mixture and formed a froth, and then agitated again and caused the mineral to sink—to break up the froth, and after doing that

two or three times, finally sank the mineral and separated it as the Cattermole granules in an up-cast?

A. I saw that experiment and watched it very closely, and I have given quite a little consideration to what has been done there and what the results are and I think it is an extremely instructive experiment. I think it is an experiment that goes very clearly right to the heart of the questions which are involved in these patents, and particularly in No. 835120. The first was to use 1½% of oil, as the statement was made at the time, and the vigorous agitation in the Gabbett cone mixer, using the baffles, too, in the circular cells, and that the speed of revolution was 1450 revolutions, as stated by Mr. Dosenbach at the time. That produced in six minutes' agitation, which was carried on with this rotation of 1450 revolutions—That produced an excellent mineral froth, which was allowed to come to rest and examined. Then, with that froth in which the oil was completely taken up with the oil film of the air bubbles, and which had been accomplished by the entraining of air,—and as this rapid agitation has been frequently described, by the beating in of air, so that it was subdivided minutely, and these minute air bubbles were coated by reason of this agitation with the oil, and they had taken up the mineral and caused an excellent mineral-coated froth, which was quite recognizable as such. Now, the sole step which was taken next was to change the speed of rotation. The baffles were not taken out in this case; it was found that leaving the baffles in and

merely modifying the rotation so that we had a different style of agitation, an agitation at 300 r.p.m.—I watched it very closely—and that style of rotation had the effect of discharging and eliminating the air which formed the froth from its combination with the oil and the mineral. Now, that agitation continued for six minutes, and at the end of that slow ~~agitation~~ rotation, and the baffles acting less clearly and less sharply, because of this slow rotation, they did not disturb the rotating mass very greatly—at the end of that period of rotation the contents of the cylinder were allowed to come to rest, and we observed no froth on the top, but on the contrary, the oil set free from its contact with the air, and the mineral set free from its contact with the air, had agglutinated and formed the sinking agglutinated mass of sinking mineral, which is pronounced the Cattermole effect. Next the speed was brought back again to 1450 revolutions by changing the connection, and it was agitated for one minute. That one minute of supplementary agitation again reproduced the froth, because that agitation at the high speed again entrained the air and subdivided it finely and allowed the oil to spread itself in the air film again and to pick up the concentrate mineral, producing the mineralized air froth. I should say that that was again changed, and rotated at 300 revolutions, and granules were formed, and they were taken off finally, five minutes being used for the second slow agitation. I think this experiment is extremely illuminating, because it shows that the production of the mineralized

Samuel P. Sadtler

ir froth and the production of the Cattermole granles, using the same amount of oil, the same vessel, verything being absolutely the same, with the sole lifference of the type of agitation, is the key to the ituation, and that the statements, therefore, in patent 335120 in regard to the new phenomena produced by owering the percentage of oil relative to ore— think are based on false reasoning. I think it has een built up there on mistaken premises, and I think his experiment, if studied carefully, shows that fact.

RE-CROSS EXAMINATION,

BY MR. WILLIAMS:

RX-Q. 577. I understand from the evidence that you have just given that you adopt these large scale operations which have been testified to at the Butte & Superior plant, the Chino, the Ray, the Utah Copper Company Arthur plant and the Utah Copper Company Magna plant as representing the prior art. Is that correct?

A. They are entirely in consonance with the prior art, with mechanical improvements, but no new principle added.

RX-Q. 578. And what prior art do they represent?

A. The prior art developed by Everson, Froment, and Kirby.

RX-Q. 579. And which is represented by the operations of the Butte & Superior Copper Company?

Samuel P. Sadtler

A. There is no new principle, other than that which was already developed by the Everson second process, with some additional light thrown upon it, but no new principle added, by the Froment. I should say that the Everson alone gives all the principles involved in the present application.

RX-Q. 580. But I am concerned, not with principles, but with operations. What prior art patent is represented by the operations of the Butte & Superior mill which have been described in the evidence, with twenty and a trifle more pounds of oil to the ton of ore, carried on in the Janney machines?

A. There has been no description of the Janney machine in the prior art, that is true. There has been no description of the various mechanical appliances, but the principles of the process which is there applied by improved mechanical devices, has all been disclosed in the Everson patent.

RX-Q. 581. But these operations of the Butte & Superior mill with one per cent and a trifle over one per cent of oil, what prior art do they represent?

A. Everson and Froment.

RX-Q. 582. Everson and Froment?

A. Yes, sir.

RX-Q. 583. How do they repeat Froment?

A. Froment used small quantities of oil as described in his description, one per cent and two to two and a half.

RX-Q. 584. We will take the Froment patents. Do the Froment patents describe 1% of oil?

Samuel P. Sadtler

A. No.

RX-Q. 585. We will take the Everson patent. Does the Everson patent describe one per cent of oil?

A. It does not describe any per cent. It gives an example, which, reckoned out, makes 17%, but it does not describe any per cent.

RX-Q. 586. So that it only describes an operation with 17% of oil?

A. That is the only example.

RX-Q. 587. Now, we will take the operations of the Utah Copper Company Arthur plant with one per cent of oil and a trifle over. What prior disclosures are reproduced in those operations?

A. I have the same answer as with regard to the Butte & Superior, which you spoke of. We have the principle already stated which is involved there, with mechanical improvements, and the per cent of oil is not limited in that statement of the principle in Everson.

RX-Q. 588. Then you stand upon them as representatives of the Everson, reproductions of the Everson?

A. With the mechanical improvements and the experience gained by the working out of those principles.

RX-Q. 589. With improvements and knowledge and experience which have followed the introduction in this country of the process of the patent in suit, isn't that right?

A. Yes; there has been an immense mass of experimental work done in all the mills, which contribute to it.

RX-Q. 590. And as to the other plants, the Chino and the Ray, I presume the same thing applies?

A. The same would apply.

RE-DIRECT EXAMINATION.

BY MR. SCOTT:

R-Q. 591. As regards all of these plants just referred to on cross examination, the Butte & Superior, the Arthur, Magna, Chino, Ray, which have been operating with quantities of oil upwards of one per cent., I would ask you, considering this as a process, as the application of principle regardless of the particular forms of the mechanism used, whether or not you find any principle or operation in practice in these mills which is not set forth in the Everson patent, the Froment British and Italian patents, and the Kirby patent, and the articles in the California Journal of Technology?

MR. GARRISON: I object to the form of the question; it is entirely improper to ask an expert such a question.

MR. SCOTT: The question merely calls for whether he finds in these operations the application of principle not disclosed in this various literature. The question was objected to as improper, but there is no

Samuel P. Sadtler

reason given. That is all I can say to the objection in that form.

MR. GARRISON: I think it is obvious, if the court will indulge me. The counsel has simply formulated what he desires to have testified and the witness was left simply to say yes or no. It was entirely the evidence of counsel.

THE COURT: Objection sustained; you can change the form of the question.

MR. SCOTT: Do I understand the objection to be that the question is leading?

THE COURT: I think it is leading; that is to say, it is your statement to which he is to give a yes or no answer, merely to assent or dissent from your statement.

Defendant excepted.

R-Q. 592. State, Doctor Sadtler, what you consider the essential steps and the essential ingredients used in the process as practised by these various mills named in my previous question—what you consider the essential operations and the essential substances used.

A. The essential conditions of the illustration of the principles which have been given in the prior art are, the presence of the finely ground ore with the addition of a sufficient amount of water to make a freely flowing ore pulp, and the addition of oil which oil has a selective action, as defined, a large number of which are enumerated by Everson; and then thorough agitation, which will bring about a commingling

Samuel P. Sadtler

of these ingredients. Under those conditions we have, following the laws of physics, certain results, which results are first, the formation of fine divided air bubbles coated by the oil film, and it has been shown that that amount of oil may vary over wide limits; those oil coated bubbles have the power of condensing into their film metallic sulphides, mineral particles of that type, and of rejecting the gangue material, and the agitation provides the conditions for a separation, by reason of the formation of this mineral coated froth, which, flowing into the spitzkasten will separate, and is then by mechanical means is taken out and afterwards treated. The tailings can be retreated, which is already indicated in the early literature; retreatment is spoken of in that California publication, and also in the others, and therefore we have all the conditions pointed out for following a successful operation in practice. Many mechanical devices had to be introduced, and very considerable experience had to be gained as to how it would work to the best advantage in the application of these principles, but the principles are all there, and the practice of these mills has not added anything that I can see to the understanding of the principles stated.

WITNESS EXCUSED.

Thomas A. Janney.

THOMAS A. JANNEY, recalled on behalf of defendant, for further

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Mr. Janney, have you recently conducted any mill operations with quantities of oil out of the ordinary?

A. Yes, sir; on April 29th our plant ran for eight hours, and I used 323.78 lbs. of oil per ton.

Q. 2. Was this test conducted under your personal supervision?

A. It was.

Q. 3. And in your presence?

A. I was there the largest portion of the time.

Q. 4. And to whom did you give immediate charge of the operation when you were not there?

A. Mr. Rex Sutherland.

Q. 5. Is Mr. Rex Sutherland here?

A. He is.

Q. 6. Who co-operated with Mr. Sutherland in this operation?

A. Mr. George Taylor and an operator whose name I have not got.

Q. 7. Is Mr. Taylor here?

A. Yes, sir.

Q. 8. In the taking of samples who participated?

A. Mr. Meading, who is our head sampler, had

Thomas A. Janney.

charge of the sampling, and he himself took the mois ture samples of the feed going to the machine, wit the exception of two samples which were taken whi he was at dinner, and those two samples were taken b Mr. Mower.

Q. 9. Are Mr. Meading and Mr. Mower here?

A. They are; and Mr. Mower had charge and actu ally took all of the samples for oil analysis and meta analysis and the tonnage samples.

Q. 10. By what you have said it seems that h took all of the samples except the moisture sample and he took two of them?

A. Yes.

Q. 11. And that the others were taken by M Meading?

A. Yes, sir.

Q. 12. Now as to the assaying of all these sample of the mineral first; that is, metal and insoluble, wh performed that operation?

A. Mr. Martin, our chief chemist.

Q. 13. And is he here?

A. He is.

Q. 14. Did he do this personally, this assaying?

A. Yes, sir.

Q. 15. You said duplicate samples were taken what was the second sample for?

A. One sample was taken for oil analysis an the other sample was taken for metal analysis.

Q. 16. That is the one you just referred to tha Mr. Martin assayed?

Thomas A. Janney.

A. Yes, sir.

Q. 17. Who made the assay for the oil?

A. Mr. Clauson, our oil chemist.

Q. 18. Is he here?

A. He is.

Q. 19. Now, will you describe first the apparatus in which this operation took place, stating whether it was part of the mill equipment, or what it is?

MR. GARRISON: At an appropriate time, if your honor please, I desire to introduce an objection. I do not care to object until counsel has fully gotten upon the record the equipment used or whatever the thing is, but I desire to warn the witness not to answer if he is asked to describe the experiment until I have had opportunity to interpose my objection.

A. The machine that I used is known as our No. 1 retreatment plant. This plant consists of two emulsifiers—

MR. SCOTT: I offer the blue print produced by the witness in evidence, the same being entitled "Flow Sheet of Concentrate Flotation Plant, Arthur Plant, Utah Copper Company."

MR. WILLIAMS: We reserve the right of objection, as this it seems will facilitate the testimony, so it would be well to have it before us.

Blue print admitted in evidence marked DEFENDANT'S EXHIBIT No. 219.

A. The plant in which this run was made is known

as our No. 1 retreatment plant, and consists of two mechanical emulsifiers followed by thirteen frothing cells.

Q. 20. I wonder if you could not point that out on the blue print so that the court can more readily understand it. It is rather small.

A. In this particular test—

Q. 21. One minute, please. Are these two mechanical emulsifiers the two cells at the left of these—of this series under the words "No. 1 plant"?

A. They are illustrated by two circles. It says, "two emulsifiers in series."

Q. 22. With that placard marking them upon the diagram?

A. Yes, sir. In this run I endeavored to make two products, one was a tailing, which was sent to waste, and all of the froth from the 13 cells was considered a concentrate. That is we did not circulate as illustrated by this flow sheet. This flow sheet represents our operations as we run from day to day.

Q. 23. The "middlings to elevator" part of this diagram did not figure when you were carrying out this test?

A. That is it, yes, sir.

Q. 24. The material just simply went straight through the 13 cells and out and that was the end of it?

A. Yes, sir.

Q. 25. Froth taken off and tailings discharged?

A. Yes, sir. Previous to the time that this test

Thomas A. Janney.

was made, in the regular operations, we circulated a middling and that middling went back to the two Dorr tanks and thence back to the flotation cell. 24 hours before this test run was made I cut out the circulating in the hope that there would be no trace of oil in the Dorr tanks when I started this run. But I found that when I started the run that there was a small amount of oil in the feed.

Q. 26. You mean as it came before you at the end?

A. Yes, sir, as it came to the flotation machine.

Q. 27. And how much was there?

MR. GARRISON: I object now to any testimony of these details of the experiment. I have no objection to their laying the foundation, the questions as to what that experiment disclosed, but I do not want to be prejudiced by evidence which I feel we have a right to exclude under our objection.

MR. KREMER: I think we all understand the situation. I think Judge Garrison might make his objection, state his grounds at any time so we might know what they are.

MR. GARRISON: If your honor pleases, this gentleman has testified that on the 29th of April, during the course of this trial, in fact only a few days ago, being a manager or mill superintendent—I have forgotten just which—he was, of one of the plants of one of the allied companies with the defendant—has, during a certain part of the day run a test. I cannot conceive under what head of evidence such testimony could be admissible. The utmost limits to which

courts have gone, so far as I know, in permitting testimony of experiments not made in court, not made under the supervision of both parties, is by experts to illustrate or substantiate from those their testimony. It is a very grave question, in reading the opinions of the courts, including the Supreme Court of the United States, with respect to such testimony, as to whether it should not by the nisi prius court be excluded, because the ordinary form that is used by counsel in objecting to testimony by reason of its orderliness is quite often not carefully considered. We object because it is "incompetent, irrelevant and immaterial."

I have always considered that immaterial evidence was evidence the weight of which was so slight that it had no materiality. Now, the Supreme Court of the United States and other courts in this country, in dealing with the situation of experiments carried on by a party as an experiment and testified to by them have practically said that such things are immaterial; they should receive no consideration.

But it is a waste of time to discuss that further than the sidelight that it casts upon the objection I am making. This gentleman is not there as an expert; he is not going to testify as to Kirby and Everson and Froment and so forth. He is a practical man; he is a fact witness and nothing else. I think it is the third time you have been on the stand.

THE WITNESS: Twice.

MR. GARRISON: The second time he has been upon the stand to testify with respect to operations

Thomas A. Janney.

with respect to the operations at his mill, as a fact witness. Now, isn't it most ridiculous—now, is it not a most remarkable sight, during the course of a trial—and I am going to use a word now in no offensive sense—evidence is manufactured and brought in. He goes off to manufacture this piece of evidence. He makes it and produces it. It is a fact question. He brings it in here with no possible opportunity for us to have any such relation to that fact as gives us a chance to test its verity. We will have nothing whatever except things written down upon a piece of paper.

Now, it is bad enough if the rule is held to be extended to experiments made out of court during the course of a trial by experts; but to a certain extent, the situation is alleviated there because necessarily he has to tie these things into a theory; and, if his theory is unsound or his theory is one of those rapidly changing theories, as all the theories in this case seem to be, it is not of much materiality, it doesn't hurt anybody very much, because what they think today they don't think tomorrow and we don't much care on what experiments they base their conclusion. But this is not this situation. This is a fact. This gentleman here is a fact witness. He is going to testify to facts. Now, I respectfully submit that in the whole course of the production of the body of law and of evidence in this country, I doubt whether you can find an instance where courts have countenanced the making of facts during the course of a trial.

How is it relevant to any issue in this case? The

issue in this case is as to whether the patent in suit is valid and whether the defendants have infringed it. They have confessed infringement in their stipulation. Therefore, that issue is out of the case. How can this possibly—this fact that this witness made on the 29th of April—cast any possible light here on the question of whether the patent in suit was valid when issued? It cannot. Therefore under no law that I can see, that this case has developed, can this testimony be relevant or material or competent. I object to it as incompetent; I object to it as immaterial; I object to it as irrelevant.

MR. SCOTT: Now, in the first place, as to the time of this operation. I fail to see that that has any bearing the admissibility of the evidence. The investigation of a fact sheds light upon the fact regardless of whether the investigation is made during the trial or before the trial. We have had many experiments here already that may have been devised during this trial—doubtless they were. It is entirely immaterial. They are accepted as a means of shedding light upon the question at issue; and I cannot conceive how the question of time has anything to do with it.

Now, as to its having no bearing upon any question at issue here. It has the most direct bearing. The patent is based upon the assumption and has for its only foundation the proposition that there is a different phenomena taking place when the amount of oil is reduced below a certain alleged and fictitious critical amount. Now no one can deny that this experiment

Thomas A. Janney.

will shed light upon that question; that it will show that this fictitious amount is an absolute myth.

And as to the presence of the other parties at this experiment, the books are full of cases to the effect that it does not run to the admissibility of evidence at all. Of course the court in considering any evidence doubtless always will take into consideration the circumstances under which the experiment, regarding which evidence was offered, was performed; but this is a matter of credibility that has nothing to do with the admissibility of this evidence.

And, furthermore, here three or four days ago when we started to prove an operation similar to this one to which this witness will testify some objection was made on the ground that the other parties were not present. After some discussion we invited them to be present, to compare the operation. The offer was accepted and the acceptance of it is in the record and we have proceeded in view of that state of affairs, and we have five witnesses here this morning. We have all of the necessary witnesses to corroborate all of the details of the operation. And as far as the Supreme Court of the United States and as for there being dozens of decisions, or some such number as that, to the effect that the experiments by experts should not be considered, I can point to any number of cases in which the decision is hinged upon precisely such experiments. They have always been considered. I doubt if we will have any difficulty in bringing in cases upon that point.

Thomas A. Janney.

Therefore, I see no legal objection to this witness proceeding with his testimony. The operation to which he testifies will be repeated under our previous offer and thus the only objection, even to the credibility of the operation, is removed, and I maintain that no objection dealing with the admissibility of the evidence has been offered.

MR. GARRISON: Now, if your honor pleases, Mr. Scott has with utmost frankness disclosed the purpose of this testimony. He has said and of course I do not have to concur in his construction, but he has said our entire patent depends upon a certain statement with respect to phenomena. He proposes by this witness to prove that the patent rests upon a falsehood. This evidence, if admitted in this case as evidence, he says will be decisive positively of the entire case. So that we are faced with a critical situation which, according to our opponents, our entire case is to be determined on whether this witness can testify what he did on the 29th of April and the results thereof.

Now, this phenomenon is one which requires for a determination expert knowledge of exactly what has been done and the results. We are so saturated now, after three weeks of this trial, that we know that the result, the method of operation, the mechanical principle, the nature and character of the froth, the position of the mineral, the situation with respect to the gangue, the action and subsequent appearance or disappearance of the oil, the action and subsequent appearance and disappearance of the acid, are all things of importance that cannot be exaggerated.

Thomas A. Janney.

Now, we cannot see any of these things. We are going to be faced with statements by this witness that the critical things which make this experiment, made where they wanted it to be made, were present, and how can we possibly disprove whether they were present or not. The only set of eyes, the only mouth, the only brain, that can testify is this gentleman. He is here proffered by the other side, and of course it is without any question therefore to be assumed that he will say that the things were present which are determinative, so Mr. Scott says, of the issues in this case.

In other words, we have got this proposition: That during the course of the trial with respect to a fact, a witness may be permitted to depart from the neighborhood of the court room, produce a certain set of facts, come in and testify to them and thus dispose of the case absolutely! If that can be permitted, if that is permitted, it does seem to me that all of the rules of evidence that it has taken centuries of care to build up in order that justice may be administered, with due respect to the opportunity to test the proof, are done away with.

MR. SCOTT: One more point I would like to make, your honor.

Now, this same objection, identical in substance and form, was made the other day, and an additional objection was made that the testimony then offered was hearsay. Now that was fully considered and after the noon recess I addressed myself to the court for the

purpose of getting a complete understanding of the situation and I think I am correct in saying that the court's ruling in excluding this testimony was based simply upon the ground that it was hearsay, and upon no other ground.

THE COURT: Yes, but the court did not commit itself to any other proposition at that time. Even if it did, if the court was wrong at one time it wouldn't have any hesitancy in changing at another.

MR. SCOTT: I did not intend to make that argument.

THE COURT: Here is the proposition as the court sees it: Under proper circumstances, I do not think it is an objection to an experiment that the other side have not had an opportunity to be present, but experiments are of value, probative value, in any case, if they are had and made under the conditions of the act or fact which they purpose to illustrate. Now, this patent has been issued some 12 years, and you are having experiments today, as I observed the other day, in the light of 12 years' development and four remarkable years—or years of remarkable development of the process of this patent in suit. Now, are they under the conditions as they were when this patent was issued, when this discovery was made.

MR. SCOTT: They are the conditions with the quantities of oil that were stated were in the prior art precisely. These experiments he tried run up to about 16 or 17 per cent, I think, or as a matter of fact, three hundred and twenty-some pounds. The same quantity

Thomas A. Janney.

of oil that Everson mentions, approaching the quantity that Kirby mentions far in excess of the quantity mentioned in the California Journal, and far in excess of Froment's quantity, and it is upon the presumption that the improvements set forth in this patent is a new process, growing out of the reduction of the amount of oil named in the prior art. Now, we conducted these operations with exactly the steps described in the prior art—nothing to it except the powdered ore, the water, the oil, the agitation and the froth, and those are the things that are mentioned in the prior art, and that the prior art tells us how to do, and we have used this quantity of oil, the quantity mentioned in some of the prior art documents and beyond that mentioned in others, and we come here before this court confronted by this decision against us based upon the existence of a so-called critical point which marks of this patent from the prior art. We produce an experiment in which we use the quantities of the prior art with the step prescribed by the prior art, a quantity far in excess of that so-called critical amount; and I fail to see how the experiment can be immaterial, how it can have too little weight. It meets the issue squarely. It does what the patentees say cannot be done. It does what the prior art inventors said could be done.

THE COURT: Well, if it wasn't being done in those days and couldn't be done, if nobody knew how to do it and now, as you say, after all of these experiments you develop it is seen that it can be done, ought to have been done then, is it material.

MR. SCOTT: We follow the exact directions of this prior art, and these patentees are no more warranted in coming before this court and saying that a given person is following their directions than the other patentees are in coming in and saying you are following my directions. The only respect in which anybody ever followed the directions of this patent in suit in a respect not shown in other patents, is in the practice of economy. And other patentees and inventors have set a sufficient amount, they have said as low as one per cent, and then this patentee happens to make a lucky guess that this process could be made successful, that it could be done with less than one per cent.

THE COURT: It is like all other attempts to solve a problem. Others had worked on it, of course, and all, so far as the evidence shows had practically failed in producing the particular froth that this patentee did. In due course of time these people—yes, perhaps by a lucky guess or a lucky accident—took the step and made possible, perfect what before they were simply striving to do.

MR. SCOTT: Our position upon that, your honor, is that these patentees did not tell us how to do it with less than one per cent. They said: "Do the same thing that all of these prior inventors did" and guess that you could do it with less than one per cent.

THE COURT: Well, at any rate we are coming pretty close to the end of experiments that the court will receive. I will give you until two o'clock, both of you, to bring in the authorities on this question of ex-

periments. The patent law must be full of it. You have mentioned them several times, but I haven't seen any authorities on these experiments. Let's have them at two o'clock.

WHEREUPON an adjournment was taken until 2:00 p. m. Friday, May 4th, 1917.

2 p. m. May 4, 1917.

MR. GARRISON: If your honor please, your honor will recall that in the early stages of this case, when the defendant began the introduction of present day operations, an objection was interposed that it was not relevant or material to any issue to be tried in this case. At that time I presented to your honor a series of authorities in England and in this country directly in point, the point being that where the question of validity is involved, and it depends upon the state of the prior art, no testimony is admissible with respect to the prior art unless it is given from the standpoint of the prior art, and the testimony which refers to the prior art in the light of later developments has but one purpose, and that is to confuse the issue and make it difficult for the court to see what otherwise would be simple. Mr. Scott, representing the defendant, at that time met the challenge and stated that he would connect these later day operations with the prior art, and would show that they were demonstrations of the prior art.

This test about which they purpose calling this witness, performed within a week, does not purport by

any of the testimony given by this witness—and by that alone can we test it now—to reproduce the conditions of the prior art. This witness is not proffered as an expert with respect to the prior art.

I find that the cases have had to deal with the conditions existing prior to the rule which now prevails respecting the trial of patent cases in open court. Of necessity courts in the past have had placed before them for their consideration all of the testimony taken before the master or examiner in chancery who took the testimony, and therefore the courts dealt with the evidence of experts with respect to tests from the viewpoint of the testimony that was already in the case, and the question was what should be done with it. Therefore it is not remarkable—in fact it would be very remarkable were it otherwise—that we do not find any law with respect to the admissibility of the evidence. We do find expressed in the disposing of the evidence what indicates the duty of the Nisi Prius Court under the modern rule, under which testimony is taken in its presence.

As a basis for what I shall say I refer to 83d Fed. Pages 696 and 697: "The complainant has endeavored to demonstrate that this testimony is untrustworthy and his expert has introduced a series of experiments to show that the method described by the defendant is incapable of producing a seamless cap. That complainant's expert should prove the defendant's methods inoperative is not surprising. An experience of 1~~8~~4 years in patent litigation has convinced the court that when an expert endeavors to prove that his adver

sary's machine will not work, he is always successful. It is much easier to make a machine that won't."

177 Fed. 717, page 721. The court said: "I give no weight to complainant's experiment made in the absence of the defendant; such attempts at the making of evidence are not to be encouraged."

165 Fed. 909-11. "We disregard altogether the reports of tests made apparently by a skilled operator, some of them in the absence of complainant or of doubtful interpretation and in all so few as to be valueless."

179 Fed., 701—at 77. "The record discloses attempts to demonstrate actual identity, but these are not produced in such shape as to avail the appellant. The courts place little weight on ex-parte demonstrations in any case, but especially is this true in regard to experiments with chemicals."

Now, keeping in mind that all these rulings were made where the evidence was already in the case, we find that even there, in dealing with experts, the courts have said that they disregarded their testimony. Now, if we disregard testimony, it must be because it is either irrelevant or immaterial or incompetent, and I assume that this was disregarded because it was immaterial, because it had no weight.

However, the main grounds for the exclusion of this evidence, it seems to me, is furnished by the facts that are incontestable. Its only possible relevancy would as to the matter of validity; there will be no pretense that it carries any weight whatever as to the question of infringement. Now, what materiality, what rele-

vancy can a procedure at the Utah plant, carried on in a machine invented three or four years ago, with materials not those of the prior art, in a manner not disclosed by any procedure in the prior art—have upon the question of validity in the case at bar. Without any extended discussion, we are advised from the view point of the defendant, as testified to by their experts, and the only one who has dealt with the prior art—Froment, with his (according to them) olive oil and the test tube; Mrs. Everson with her bread kneading process and her other process by which the position of the gangue and the metal is ~~recovered~~ reversed and the metal is washed off by methods well known in the wet separation of ores; and Kirby with his gentle agitation and elevation of an oil layer with the mineral clinging between the oil and the water and separating, by the novelty of his invention, which is the injection of oil and air—all are illustrated by methods in which none of those methods are used, none of those procedures are carried out, and a totally different result is achieved.

As to how far courts will permit experiments, I think without exception one in limine procedure is required of the person presenting the experiment, namely, that the conditions under which the experiment is produced are identical with those that they pretend to repeat. I have not attempted to bring with me the citations or quotations from the innumerable cases which hold that. What our positoin would be were these gentlemen to proffer through the mouth of this witness testimony of what he found to happen in a test tube

in Utah in the attempt to put olive oil and sulphuric acid and shake it up, according to the way he read the Froment patent, I will not take time to discuss. What would happen, similarly, if he told us what he did in his room in his home in Utah, by kneading the mass, according to Mrs. Everson, or by taking some apparatus well known in the wet separation of ores and following her second practice—or if he constructed a Kirby machine and operated it in his own room and told us the results—I will not say what position we would take toward those; but we think these gentlemen have themselves laid the ground work for showing that what this gentleman proposes to testify to is ~~conditions~~ in no way identical with those which they purport to represent—there is no possible basis in the law of evidence or the law relating to the trial of issues in patent suits to justify or vindicate this evidence, and there is an entire failure of it in such evidence, and I think the witness has already testified, when he was identifying his flow sheet, that these were Janney machines, and the evidence is already before you that they are a matter of three or four years of age; so that it is demonstrated before your honor that this can not possibly be any reproduction of conditions existing at the time of Froment, at the time of Everson, or at the time of Kirby, and if they are not, then there is no possible basis whatever for the introduction of this evidence in this suit.

MR. SCOTT: First, as to the identity of conditions, of course we all admit that the conditions of any incident must be reproduced with substantial identity.

I never knew of any requirement that the impossibility of absolute identity be complied with. Now, the only question of any importance bearing upon this matter is the mechanism employed. The patent in suit discloses and the complainant's testimony is that the apparatus there used was known 20 years before the patent was applied for or the alleged invention made. It is in evidence that all kinds of agitating apparatus were in existence before the prior art documents upon which we rely. That is the identity. We used agitators in this process before the court. It is not a question of mechanism. The process involves the mechanical step of agitation. The only elements involved in the process are these: the powdering of the ore, the mixing of the ore with water, the addition of oil and the agitation. This completes the whole process from beginning to end, and no question of identity can come up as far as to the process. That is the process as shown to the court, the apparatus was all known at the time.

Now, the authorities that Mr. Garrison has been reading simply confirm what I told the court this morning, that this question of experiments, whether made ex-parte or inter-partes, no matter how performed, merely goes to their weight and has nothing to do with their admissibility. Every case read by Mr. Garrison enforces this point. The point has never been analyzed in patent cases, so far as I know, because these experiments have always been received, and if we look into the patent cases all we see is the analysis by the court of the experiments with a view to judging their weight as evidence. In the general law,

r course, the instances are many where these cases ave been analyzed and there is one case in particular hat I have a note of. That is Berg v. Chicago & Rock Island Railroad Company. In this case the plainiff's children—two children had been injured on deendant's railroad tracks, and the defendant without otice to the plaintiff made certain tests to show that ne theory of plaintiff as disclosed in the pleadings was ntenable, and upon that state of facts the Supreme Court of Iowa commented as follows: "Defendant nade certain tests without notice to the plaintiff. The ourt admitted proofs of these tests over the objection f plaintiff." The court goes on to say: "We think nese tests were proper and if fairly made the facts icslosed thereby would be of great value in reaching a onclusion. We cannot adopt appellant's view that it s an attempt to manufacture ex-parte testimony. Intances are without number where, pending litigation, ne parties have made tests, measurements and trials elating to facts in dispute, and they have been regardd as competent and as a quite satisfactory class of vidence upon questions of fact, and we are not favred with the suggestion against the reason of such ule. Upon the question of the admissibility of such vidence, courts have never assumed that it was "manfactured" in the sense in which the term is used in rgument. It is not the law that in making such tests, neasurements and so forth, the opposite party is entled to notice in order that he may be present. It is he right of each party in the preparation for trial to ake all legal steps in the way of being able to meet

the issues of facts by proof, and in preparing for th
presentation of his evidence no notice to the advers
party is required. When they are used—

That is the test—"When they are used the circum
stances of their use, including motives for and all th
conditions of an unfair or impartial use are matter
that may lessen the value of the testimony." That i
the end of the court's comments. That is the case o
Berg v. Chicago & Rock Island Railway Company, 5
N. W. Reporter, 680, and it is found in the Suprem
Court reports of Iowa 90th volume, page 106. In th
case of Byers v. Nashville Railroad Company, 94 Tenn
345, the court says:

"It is next assigned as error that the court exclude
the testimony of Henry Mangrum, who, at the reques
of the company, made an actual test to see whether th
train that caused the death could have been stoppe
after the engineer saw or could have seen the man o
the bridge. This witness proposed to prove that h
ran the same train on a different day, after the acci
dent, over the same place and bridge; that he had th
same number of coaches; that in making the test, a
soon as he could, by being on the lookout, see an objec
standing on the center of the bridge, he applied ever
means known to him or other skillful engineers, an
used every endeavor, to stop his train, and that it wa
impossible to stop such a train before passing over th
bridge; and that his entire train passed over the bridg
before he was able to stop it. He further would hav
testified, if allowed, that he applied his air brakes, re
versed his engine, and used every means known to en

gineers to effect the stop, but was unable to do so. This test was made by Mangrum for the purpose of making him a witness and proving the result of the test. This evidence, on objection, was not allowed to be given. The authorities in other states are conflicting upon the admissibility of such evidence, and we have been cited to many cases, all of which we have examined. In our own state it has been held that the evidence of an expert is not incompetent because of an ex parte examination, investigation, or experiment made by him. Nor is such evidence inadmissible because the experiments were made after the suit and trial has begun, and with a view to being used as testimony in the case. The objection in such cases goes not to the competency or admissibility of the testimony, which is a matter for the court to determine, but to its weight and sufficiency before the jury; and especially is this the case where the experiment is made ex parte, and is such that it lies wholly within the power of one party, and wholly beyond the power of another party, to make such experiment. We have been cited to quite a number of authorities to sustain the contention that such evidence is incompetent and inadmissible in cases where the experiment is not equally within the reach of both parties, but we have not been able to find this doctrine sustained. We do find cases, however, holding that, where the experiment is made ex parte, it affects its weight that it was not made after due notice to the opposing party, and giving such party opportunity to be present and see the test applied. That such evidence is compe-

tent, but its weight to be duly weighed by the jury, i
supported by the following authorities: Boyd v. Stat
14 Lea, 161; Lipes v. State, 15 Lea, 125; Railroa
Co. v. Ayres, 16 Lea, 725; Railroad Co. v. Champio
(Ind. Sup.) 32 N. E. 874; Underh. Ev. P. 201; an
other cases in accord. It is uniformly held that i
all such tests, to make them competent, the condition
under which the tests were made must be the sam
as near as practicable. This requirement appears t
have been substantially complied with in this case
and, judging from the testimony offered to be give
the conditions of the test were essentially the sam
as when the accident occurred. We are of opinio
the trial judge was in error in not allowing evidenc
of this test to be introduced, under proper instruction
to the jury as to its weight. We cannot speculate o
what might have been the verdict of the jury if thi
evidence had been allowed to be introduced. It wa
upon a vital point in the controversy. The plainti
had been permitted to prove by a witness that he ha
gone upon the tracks, and measured the distance a
which a man could be seen standing in the middle o
the bridge; and a hot contest was made over the ques
tion how far a man could be seen on approachin
the bridge, and opinions pro and con were introduce
on the question whether it would be possible to sto
the train after reaching a point where a man could firs
be seen by a lookout upon an approaching train. Thi
is the turning point in the case, and the evidence wa
very conflicting; and for the error of the court i

rejecting evidence of this test, properly limiting its weight and sufficiency, the cause must be reversed and remanded for a new trial."

Now, there is a parallel between that case and this case. Here, this patent before the court is based upon an experimental test. Some gentlemen in London, some 11 or 12 years ago, took a little laboratory machine such as we have here, with their knowledge of the prior art, either actual or constructive, and it makes no difference which, although probably actual, with full knowledge of the prior art respecting the quantities of oil which this witness will say he used, and smaller quantities and larger quantities, with full knowledge of those facts, they take this little apparatus and perform an experiment with which they get a froth with less than one per cent of oil, and then they go forth to the world and say: this is a discovery, these people that went before couldn't do this and no man ever did it before.

We offer this testimony to show that what these prior art inventors disclosed could be done when they invented it, could be done when these men in London put this fiction before the world, and that it can be done today. What are the conditions of the prior art that we reproduce? They are the powdering of the ore, which this witness has done in this experiment or had done for him; its admxiture with water, the addition of oil in the amount named in the prior art, larger quantities maybe than the prior art inventors named—and the last step, agitation. Here is represented every condition. He has done it in a

receptacle made of iron while some of these prior art people may have made it of wood. It may be that he turned the agitator with an electric motor while they may have used a water wheel. That is no departure from the substantial identity of conditions. And therefore I maintain that there is not a single criticism put forth by Mr. Garrison that will stand the test of adjudicated cases or of reason.

MR. GARRISON: I only want to say one thing, to say that the cases all hold just as Mr. Scott has read from his cases, that the person performing the test has illustrated that the conditions of the test represent and reproduce what they purport to represent and reproduce, in his case a railroad track, same engine, same cars, same place, same bridge. Until they do that, it is not admissible, and so far from their having laid that groundwork, their testimony shows that so long as they use this equipment that they have at this mill they cannot even pretend that they are representing anything that the prior art disclosed or anything that puts us in the position of the prior art.

THE COURT: The court will consider for a moment what was said when this character of evidence was first offered.

(Whereupon a short recess was taken.)

THE COURT: This objection seems really to bring us right back to where we were on the day when the defense first offered evidence of what was being done in other plants for while before noon the objec-

tion was based upon the fact that experiments are not admissible at all, and while that ground has not been abandoned since noon—and I think before noon the objection was also made that it was not illustrative of the prior art—all of that was met by the court's ruling originally when this character of evidence was offered at that time, that it was going to be, as the defendant promised, connected up and shown to be illustrative of the prior art. As I have said before, the proof in this case must be that of the prior art. Mere subsequent developments, improvements, discoveries, will not have weight and properly can have no weight in the final determination of the case. But it is said still that this was the prior art. As far as experiments are concerned, they are subject to both criticism and suspicion. I would not go as far as the cases that counsel has read from, absolutely refusing to consider such evidence altogether, the 177 and 165th and 179th Federal—or that expert testimony before the court is of no value, because it does not seem to me that that is in accord with either logic or principle; it does go to its credibility or weight, and how much the court will give to either to that variety of testimony. It is necessary that the conditions shall be the same of course, or otherwise the experiment is wholly misleading. I suppose every judge who has sat on the bench has had plenty of evidence of experiments brought before him one time or another. The case counsel read from last indicates that, and also it has been so in this court. Conditions must be the same. If John Doe was being

prosecuted for shooting Richard Roe with a gun at a distance of 500 yards, it would certainly be competent for the defense to come in and show that the gun, by actual experiment, would not carry that far; but it would also be necessary for the defense to show that it was at the same range and the same sort of ammunition, that the gun was held at the same angle or at least at the most favorable angle; for if it was shown that the shot was fired at a thousand yards, the experiment would be worth nothing. I think the court observed in a former ruling as to what can be done today as to experiments is correct, that it all turns on the substantial identity. Another remark the court made was that there is already evidence in this case that the defendant is operating and has operated with more than one per cent of oil specified in the patent, and plaintiff not having explained its position in reference to that—the time not having come—it might be that the plaintiff might claim that such operation could not be conducted with that amount of oil. Certainly, to meet that contingency, the defendant would have a right to show that they can be conducted. Plaintiff might claim that they could not be conducted under any other conditions than the Butte & Superior conditions, and it would be competent for the defendant to show, as corroborative, that they can be and that they are being conducted elsewhere.

Now, this experiment which the defense proposes

to put in evidence is of the same character of regular operations; I think you might say that it was conducted long enough to bear a semblance to the regular operations which are covered by the stipulation. I think one of the objections raised the other day was that it was only an hour, and hence it could not come within the stipulation.

Having started out upon the theory that the defendant can introduce this evidence as illustrative of the prior state of the art,—Of course it must be shown by proof; it is not sufficient to claim that is the prior state of the art—The court will not change its ruling now, but as I said before you are getting close to the limit as to the number of these experiments which you will be allowed to show. As Judge Holmes puts it in a Massachusetts case, the court must control that, and not allow them to continue for the length of a man's life, if not for eternity. I can not wait here while you go to Utah and make experiments indefinitely. So this objection will be overruled, but bear in mind that you are getting pretty nearly to the end. I am not prepared to say that counsel has failed—He has not put all his case in in defense yet—to show that these conditions come fairly within the prior state of the art, but I am prepared to say that counsel has a heavy burden on him to show that. Of course I have observed here before that this case is being tried, as far as the evidence is concerned, as though the Hyde case never existed; but with the presumption of validity attaching to the patent in suit, and the

Supreme Court standing back of that patent, the defense knows what it has to overcome. So we will allow you to proceed, and in the end we will see whether it is, as you claim it is, illustrative of the prior art.

MR. SCOTT: I would like to inform the court that I wish to present this witness, and that after that we have in the Grand Jury room a model machine which we would invite the court to see operate.

THE COURT: I might have said I do not see why these experiments should not have been made in the plant here at home. I don't see why you should invite the plaintiff to run outside of the jurisdiction of this court to see these experiments. I say you are entitled to introduce them under the plaintiff's authorities, regardless of what some of the Federal authorities say—entitled to introduce them, whether they have seen them or not. It goes to the weight and to the credibility; at the same time I do not see why these experiments should not have been conducted in the plant here. The court might want to see them, and of course the court is not going out of the jurisdiction.

MR. SCOTT: It was a matter of convenience as to which plant could most handily do it. The plant which we refer to is a model plant, installed on the upper floor, and we would like the court to see that.

THE COURT: Of course the court is not saying that you have put in your last experiment, but is simply suggesting, strongly, that you have used pretty

Thomas A. Janney.

nearly what the court would consider a reasonable time. The objection will be overruled and an exception will be noted.

Q. 28. Do you remember, Mr. Janney, the point that you had reached; we were discussing the construction of the plant, and you had stated that it was your No. 1 retreatment plant, consisting of 2 emulsifiers and 13 frothing cells. Will you complete your description of the plant in which you conducted this operation with 323.73 lbs. of oil?

A. In my earlier testimony I described that we had two emulsifiers and 13 frothing cells in series. All of the concentrate from these 13 cells was sent directly to the concentrate bins, and the tailing was sent directly to waste, and there was no circulation, as in the operations previously testified to.

Q. 29. Now, before you begin this test, as I remember, you stated this morning that you took some precaution to prevent any oil or any great amount of oil additional to that directly added being present?

A. Before I left Butte I telegraphed to Salt Lake, or to Garfield, rather, to have the circulation discontinued.

Q. 30. By circulation you mean the return of the middlings?

A. The return of the middlings.

Q. 31. And in the regular operation of this machine, just state where those middlings did go back to.

Thomas A. Janney.

A. In the regular operation of this plant the middling was returned to two elevators, and the pulp is there elevated to two four-spigot classifiers.

Q. 32. Those marked "Janney Classifier" at the left hand of the sheet, isn't it?

A. Yes.

Q. 33. Elevated to the classifiers. What are those classifiers for, primarily?

A. I might state that, in addition to the middlings going to the elevators, the original concentrate that is from the vanners in the mill also discharges into the same elevator, and with the middlings it is elevated to these two classifiers.

Q. 34. When you speak of the material from the mill, you mean the tailings from the gravity treatment in the mill?

A. No, it is the concentrate from the vanner, and part of that feed is what constitutes the feed to the flotation plant. These classifiers are used for the purpose of removing the coarse material, and this coarse material is treated by the Wilfley tables.

Q. 35. That is indicated on the drawing by the placard "Spigot to Wilfley Table"?

A. Yes, and the overflow from these classifiers is delivered to two Dorr thickeners, 44x12 feet, designated as Dorr tanks on the print. In my previous testimony I stated that these tanks were 44x20; I find they are 44x12. The overflow from these Dorr thickeners is wasted, that is, it is not used any more, and

Thomas A. Janney.

he thickened product is divided between two plants, nd inasmuch as I am only dealing with one plant in his experiment, I will refer to that plant only.

Q. 36. The two plants are indicated there by No. 1 plant, 13 cells in series, and lower down, No. 2 lant, 15 cells?

A. Yes.

Q. 37. And you are going to confine yourself o No. 1?

A. To No. 1, yes. Now, as the thickened product rom the Dorr tank enters No. 1 plant, enters the emulsifiers, oil is added.

Q. 38. That is the place where it is so marked, 'Oil Added"?

A. Yes, and our alkaline reagent is also added at he same place. The pulp, oil and reagent passes hrough the two emulsifiers, and thence to the flotaion cells.

Q. 39. Now, Mr. Janney, I see as this sheet is nade now, that you have a placard here, "Concentrate rom Upper Cells to Concentrate Bin; Number Left o Judgment of Operator." And below that there are several other cells, the froth from which goes back as niddlings to the elevator. What is the effect of bringng back those middlings upon the oil supply?

A. It increases the oil supply.

Q. 40. Now, you had just got to the point of stating, I think, that you had the circulation cut out. You telegraphed to have the circulation cut out before you went to Salt Lake. Will you please state

Thomas A. Janney.

what the effect of cutting that circulation out was upon this oil supply?

A. Well, my object in having the circulation cut out was that in this test I would be dealing, as nearly as possible, with a pulp that had no other material in it except the feed that came from the classifiers. But the time allowed was not sufficient to allow all of the oil that was contained in these tanks to work out of the system.

Q. 41. In the Dorr tanks, you refer to?

A. Yes.

Q. 42. That is, some of the old material kept the oil in there?

A. Yes.

Q. 43. How long was this running without circulation before you started this test?

A. About 30 hours I believe it was. I believe I mentioned 24 hours, but that was just a rough figure. It was 30 hours.

Q. 44. Now, how much oil per ton of ore was there in the feed during this test, before you added the oil which you did add for the purpose of the test?

A. 1.04 pounds per ton.

Q. 45. That amount was in there by virtue of the residue in the Dorr tank?

A. Yes.

Q. 46. Would that 1.04 pounds per ton cause the formation of a froth concentrate?

Thomas A. Janney.

MR. GARRISON: That is objected to as specu-
ative.

(Question withdrawn.)

Q. 47. Did you ever use the same mixture in amount
s low as one pound per ton?

A. The lowest we used was in a test that I testi-
ied to earlier in the case, in which I used 1.6 lbs.
f original oil, and I think there were four and a
raction pounds there already, so that the total was
.68 pounds, if I remember correctly, and the results
vere negative.

Q. 48. By negative what do you mean?

A. They were not good results.

Q. 49. Did you ever run without oil at all—that
s, without new oil added?

A. Yes.

Q. 50. What was the result then?

A. I noticed a few stray bubbles on the first spitz,
hat was all.

Q. 51. What were the conditions then as to residue
of oil in the Dorr tanks as compared with the con-
lition when you conducted this test with 323 odd
ounds of oil?

A. I believe there was in the neighborhood of
four pounds per ton of oil.

Q. 52. And that gave only a few stray bubbles?

A. Yes—Well, I did not run that test with that
oil amount; that was 1.6 pounds of new oil added
to that, and I did get some froth on that test. I have

not run a test where I used just the four pounds of oil in the circulation alone.

Q. 53. You have not made a test just with the oil that was left there from the circulation?

A. Well, not knowing the quantity of oil I haven't; I have run the machine, but I don't know how much oil was in the circulation.

Q. 54. Have you a statement containing a report of the operations of these gentlemen who are here and who worked under you in conducting this test?

A. Yes.

Q. 55. Will you produce copies of it or have I got them?

A. You have them.

MR. SCOTT: I offer this statement in evidence, entitled "Utah Copper Company, Arthur Plant, Metallurgical Department, Eight Hour Test made in Retreatment Plant, etc."

Table marked DEFENDANT'S EXHIBIT No. 220.

Q. 56. What was done with the products, the concentrates and tailings before the assays were made; were they simply assayed as they came from the machine ordinarily?

A. All samples were taken in duplicate, one sample was taken for the purpose of determining the amount of oil in the product, and the other sample was taken for the purpose of determining the amount of metal in the products, and the samples taken for the oil

Thomas A. Janney.

analysis were taken by means of a cutter, having a one-half inch opening. These samples were taken every 15 minutes throughout the test, and the composite sample was allowed to accumulate during the test. The buckets containing the oil sample were delivered to our laboratory and turned over to Mr. Clauson who made the oil analysis. Like samples were taken for metal analysis, only the samples, after being collected, ~~was~~ were delivered to Mr. Mieding, who has charge of our sampling, and he saw that the samples were properly dried, crushed, rolled and delivered to Mr. Martin, our chief chemist, at the assay office, who personally made the analys~~i~~es.

Q. 57. Now, at the bottom of this sheet, which is exhibit No. 220, I find a note as follows—

MR. WILLIAMS: I wanted to read this paper before expressing any objection, and having done so, I find upon it evidence that the operations could not by any possibility be a reproduction of any of the patents that are relied upon by the defendant. The mixtures are fuel oil, Jones oil, American creosote and Yaryan pine oil. Pine oil was never used in flotation until years and years after our patent was granted; none of these other oils are the oils mentioned. There is an alkaline reagent here, 6.37 lbs. per ton, and I don't even know what it is, but judging by that plan, it is Calura, a recent invention in the art. The document shows upon its face that it is not an operation of the prior art, therefore or object to its reception in evidence and any testimony in regard to it.

MR. SCOTT: In the prior art patents, noticeably the Everson patent, she mentioned animal and vegetable oils generally, but never published all the different kinds of oils that might be used; it was impossible to name them all; Everson named various reagents to be added to the pulp, in her patent, and furthermore the argument advanced by Mr. Williams has no bearing upon the point at all. The process of Everson would be here none the less, or any of these other prior art inventions, notwithstanding that other things are here also. We have followed the Everson directions as set forth in the patent. She advises the use of a long list of different reagents, both acids and salts of every conceivable nature, and she names some of the salts she has used. She does not name them all; she names probably six or eight or ten. She speaks of the use of salts, and strangely enough, it is found in modern practice that the use of such salts is beneficial. She speaks there of the use of copper sulphate, which has been used since by the Butte & Superior.

THE COURT: It is in line with all the former testimony, and the court will adhere to its ruling. Perhaps this special objection was not made heretofore, but of course it will be a matter for argument later on. I think one witness testified to having a thousand different oils in his laboratory. Many of the results obtained today are traceable, according to the evidence, to new mixtures and combinations of oil. Whether that is part of the prior art is another thing.

Thomas A. Janney.

The question whether these oils are differently combined—and thus have different effects—I think they must, or they would not take so much trouble to mix them. At this time the objection will be overruled.

Plaintiff excepted.

Q. 58. I note at the bottom of your report, exhibit 220, the following note is made: "On account of products containing so much oil, they were dryed with an oil solvent before the metal assays were made." Explain why that was done.

A. In this particular test, during the eight hours about 14½ tons of oil were ~~was~~ used, and only 91.3 tons of material were treated. It was necessary that this oil should be washed out from the product in order to get a true metal assay of the product, and it was for that reason that I washed them.

Q. 59. Does this table show the amount of oil in the concentrate?

A. Yes, it is on the last column at the right of the sheet, on the fifth line down under the tabulation; 680.175 lbs.

Q. 60. There was 680 pounds of oil on the concentrates by assay?

A. Yes.

Q. 61. And is your pounds by weight of the concentrate increased by that 680 pounds of oil on them?

A. That 680 is not the oil contained in a ton of material rejected at the tailings, but it is the number of pounds of oil that would be carried out with every ton of concentrate produced.

Thomas A. Janney.

Q. 62. In every ton?

A. Yes.

Q. 63. Then you started with 91 tons of heads —of course that was without any oil at all?

A. Yes, that had one pound that came from the Dorr tank.

Q. 64. And would your results have checked up if you had figured your original tonnage as 91 tons, without this added oil, and then figured your concentrates with 680 pounds per ton of oil added to it?

A. I don't think I quite understand your question.

Q. 65. Well, your operation would have ended with more material than you began with if you had not taken the oil out, wouldn't it?

A. It would have ended with the amount of oil —with an amount of material equivalent to the amount of oil that I added to the machne.

Q. 66. Would another way of correcting that have been to have added the weight of the oil to the heading?

A. That would have been one way of correcting it, yes.

Q. 67. Instead of that, you washed the oil out of the concentrate?

A. Yes. I also washed the oil out of the tailings and heading.

Q. 68. Now, why is it that the combined amount of oil in the concentrate and tailing does not equal the amount of oil that you added?

A. That is due to the discrepancy in the oil analysis. On account of the concentrate containing so

Thomas A. Janney.

nuch oil I found it a difficult matter to dry off all of he water without carrying some of the oil with it. In his particular case I think it took over 24 hours to lry off the water before we could take a sample to deermine the oil in it.

Q. 69. What kind of mixture was this froth after t was broken down and was being dried?

A. This concentrate mixture consisted, after it was out on the steam bath and the bubbles broken down, f a layer of oil floating on top of the water, and s the steam would be generated underneath the oil, t would bubble up through, and I am of the opinion hat when this steam would rush through it would mehanically carry some of the oil with it. Also, on acount of the oil standing in the presence of the air so ong, I think some of the lighter oils volatilized.

Q. 70. Then the amount of oil, I see by these asays, adds up less than the amount that you actually dded?

A. They do.

Q. 71. And therefore the figures here given of the mount of oil on the concentrates and tailings would hat be less or more than the amount actually presnt?

A. What do you mean, actually present; the mount added?

Q. 72. Yes.

A. It would be less than the amount added.

Q. 73. What would be the total pounds of oil sed per ton, based upon the amount of oil in the roduct?

Thomas A. Janney.

A. A little over 217 lbs. per ton.

Q. 74. That is based on the oil assay figures?

A. Yes; based on the amount of oil in the concentrates and in the tailings, and the amount of oil was 217 pounds.

Q. 75. As against the fact that you actually did have 323.78 pounds?

A. Yes.

Q. 76. How much of that oil can you account for by the oil assays of the concentrate and tailings, as compared to the amount of oil added?

A. Approximately 68%.

Q. 77. Have you told everything that you personally did in connection with those tests—with this test so far?

A. No, I have not. I gave instructions as to how this test should be run, that is, relative to what should be considered concentrates, how much oil I wanted used, and after those instructions were given I watched the operators in charge, to check the tonnage samples and the amount of oil added, and I would go there about every half hour and see that conditions were the same.

CROSS EXAMINATION

BY MR. WILLIAMS:

X-Q. 78. How much of that oil was left in the plant at the conclusion of the operation?

A. We started the test at 5.45 p. m. April 29th, and we considered the test stopped at 1.45 a. m. of April 30th, and we discontinued sampling, I believe

Thomas A. Janney.

it was 30 minutes after we considered the test ended. That is, I had made determinations on that plant, and I found that it takes about 30 minutes for the feed to travel through the machine.

X-Q. 79. I was wondering how much of that oil was left sticking to the spitzkasten and other parts of the appliances. You have lost something like 32% of the oil. Don't you think that you lost some of it by reason of the fact that it did not come out of the plant?

A. I did not look into the machine to determine that. It would be quite a job to do that.

X-Q. 80. You don't know but what you left the plant in a pretty dirty condition as to oil?

A. Well, I can't say. What I could see was all right.

X-Q. 81. I don't find in your statement any separate determinations as to the overflows from the 13 different spitzkastens; did you make them?

A. All we would know would be the total amount that the whole 13 spitzkasten were giving forth; is that right?

A. Yes, that is correct.

X-Q. 82. Now, you ran the plant for 30 hours without circulation, but in the regular operations before the experiment?

A. That was before the experiment was started.

X-Q. 83. You cut off the circulation but you did not stop the plant?

A. That is correct.

Thomas A. Janney.

X-Q. 84. What sort of operations did you carry on in the plant in that 30 hour period?

A. Well, regular operations, using approximately 21 pounds of oil per ton.

X-Q. 85. Using what kind of oil?

A. The same mixture which was stated in the table.

X-Q. 86. So that you did not stop the machine at any time; you did not stop the plant; you just started to put in this extra oil?

A. Yes, the extra oil was started then.

X-Q. 87. Now, you said that a determination was made of 1.4 pounds per ton of oil still in the feed before the point of oil addition. What kind of oil was that; do you know?

A. We do not make a determination to determine that. I don't know what kind of oil it was.

X-Q. 88. Probably it was dissolved oil, wasn't it?

A. I can't say as to that.

X-Q. 89. Won't your examination show that?

A. No, our oil determination does not differentiate between the kinds of oil contained in the feed.

X-Q. 90. Well, your creosote had phenol in it. Would that be counted as an oil in your determination?

A. Well, to the best of my knowledge I think it is.

X-Q. 91. It is in the oil when you feed it in?

A. Yes, sir.

X-Q. 92. It goes in to solution and then as I un-

Thomas A. Janney.

derstand it your method of determination catches it although it is in solution? That is right?

A. I think so, in small quantities like that.

X-Q. 93. So that that determination includes whatever of phenol there was in that creosote that was fed to the plant?

A. I think so.

X-Q. 94. Was all the oil fed in together at the point marked "oil added here" on your diagram?

A. Yes, all the oils were mixed together and were delivered to this point as indicated on the print by means of a little centrifugal pump.

X-Q. 95. Did you heat the oils in mixing them?

A. Yes, they were heated when they were mixed.

X-Q. 96. So they went into the plant in a heated condition?

A. Yes, they were warm. They were not—well, they were heated, yes.

X-Q. 97. And of course the water at this season of the year is very cold, isn't it?

A. I don't know what the temperature of the water would be.

X-Q. 98. You would expect it to be quite cold, wouldn't you, in your plant?

A. The atmospheric temperature on that day was I believe in the neighborhood of seventy degrees F.

X-Q. 99. You don't have your water at atmospheric temperature, do you, in your plant?

A. Can't expect to, no. That is the only way I can tell you what the temperature of the water was.

Thomas A. Janney.

X-Q. 100. You didn't take the temperature of the water?

A. No, sir.

X-Q. 101. You didn't take the temperature of the oil as it was fed in?

A. No, sir, the oil was added at the same temperature as it is always added during our operations, same kind of oil, heated to the same degree. We have a vat with a steam coil running through it and that steam coil is allowed to be on all the time. We have to heat all of our oils, no matter what kind they are. Even our creosote oils have to be heated. In them there are certain constitutents that otherwise would precipitate out.

X-Q. 102. You did not give us the actual discrepancy in your figures between the oil that you put in and the oil that you got out, but I compute it as 9,388 pounds. That is a tremendous amount of oil, isn't it, to lose in an operation of a few hours.

A. Well, not considering the amount of oil used, 30 per cent I believe is what it figures—32 per cent.

X-Q. 103. Don't you agree with me that you will find people at work now to get the oil out of that plant?

A. No, our operations went right on the same; we didn't notice any difference after we discontinued this test.

X-Q. 104. Now, how about the oil that went into this dilution, that is the soluble frothing agent that was present there? Did you figure carefully all of that?

Thomas A. Janney.

A. I am not a chemist, Mr. Williams, and I am not in the position to state.

X-Q. 105. Well, when you took your samples?

A. Oh, yes, absolutely.

X-Q. 106. You took all the water that was there?

A. Every bit of that was taken.

X-Q. 107. Now, Mr. Janney, when you were on the stand before you promised to get a flow sheet of the plant and I take it that this flow sheet that you have put in is a complete flow sheet of the vanner concentration flotation plant, is that right?

A. Yes, sir. And while you speak of it there was one correction I wish to make before I forget about it. You asked me while I was on the stand before how we determined the amount of oil in our circulating feed and I said that our circulating feed was determined by tonnage samples and a representative sample was taken to the laboratory and an analysis made of it. I believe that is what I conveyed to you. But as a matter of fact, that tonnage sample is taken at the point I have indicated on this print as such, and that sample is determined by analyzing the feed for a number of tests before it goes into the emulsifier and the amount of oil found in that feed is credited to the tonnage of circulating feed. We do that for the reason that some of our oils might flow off from the Dorr tank and not go back to the flotation machines.

X-Q. 108. Of course there is an overflow from all of these Dorr tanks all the time that goes to waste?

A. Yes, sir, that is the reason why we determine our oil in the circulating feed at a point after it is discharged from the Door tank and before entering the flotation machine.

X-Q. 109. And it would be a very reasonable thing for any loose oil to rise to the top of the tank and overflow, wouldn't it?

A. Yes, sir, but I have noticed it on several occasions. As a matter of fact in my inspection, that is one of the things I noticed very closely, to see if any oil was going off the tank, and I don't know that I have ever noticed any perceptible amount of oil going over with the overflow. But in case there was any going over in the overflow, we don't credit that to our circulating feed.

X-Q. 110. I understood you had a table in which you had added certain things that I asked for. Have you got such a table?

A. I think Mr. Scott has that.

MR. SCOTT: Maybe it would simplify matters if I would substitute this exhibit instead of having the two in. It is just the same but with the added column.

MR. WILLIAMS: I think so far as the record is concerned if it appears in the record that it is stipulated that the other be withdrawn and this substituted in its place, that would be all right.

MR. SCOTT: Well, then let the record show that it is stipulated that exhibit 30 be withdrawn and the paper which I now offer be admitted in its place and marked Defendant's exhibit 30, subject to comparison by opposing counsel.

Thomas A. Janney.

THE WITNESS: I have not personally checked these figures. There may be typographical errors in it, but I will have it done and if there are any errors I will notify you.

The sheet in question was marked "Substitute exhibit 30, admitted".

X-Q. 111. What is this alkaline reagent which appears on exhibit 220?

A. That is the same reagent we use in our general operation. I believe I described it in my earlier testimony.

X-Q. 112. Calura?

A. That is the name we give it.

X-Q. 113. That originated in your plant, did it not?

A. It did.

X-Q. 114. Do you know who invented it?

A. Mr. R. B. Martin.

X-Q. 115. And it was invented, we will say, within the last five years some time?

A. As far as I know it was.

X-Q. 116. It doesn't appear in Nature, that calura?

A. No, we make it right at the plant.

X-Q. 117. Now, you haven't any of the baskets or Callow cells shown in your flow sheet. Do you use any in your plant?

A. Not in this plant we don't. It is a straight mechanical machine.

X-Q. 118. And no pneumatic attachment in any way to any of the spitzkastens?

A. None whatever.

Thomas A. Janney.

X-Q. 119. You testified about another plant, didn't you?

A. Our slime plant, yes.

X-Q. 120. Have you given me a flow sheet of that?

A. I think Mr. Scott has that.

MR. SCOTT: I will offer this flow sheet produced by the witness, the same being entitled flow sheet for slime flotation plant, Utah Copper Company, Arthur plant.

Flow sheet admitted in evidence and marked DEFENDANT'S EXHIBIT 221.

MR. SCOTT: Suppose you describe this drawing briefly?

A. Do you want me to go into detail?

X-Q. 121. Tell us what it shows?

A. It is self-explanatory. That feed that comes to our flotation plant is the slime that is produced in grinding the original ore and consists of our classifier overflow. That is delivered to one 75 by 12 feet Dorr thickener. The overflow is returned to circulating—that is, returned back to our reservoir and the thickened feed goes to the flotation plant, consisting of six independent flotation units, each unit being composed of two emulsifiers in series, followed by five mechanical air cells in series, making a total of 12 emulsifiers in the plant and 30 mechanical air cells. The feed, after coming from the Dorr tank is divided by means of a distributor pipe to each of these six independent units. Oil is added before the pulp enters the units. The

Thomas A. Janney.

tailings from the last cell of each unit is discharged or rejected. The concentrate made in these three cells is pumped to an equalizing tank or a small tank which takes up the pulsation in the pulp, and this product is distributed to five independent units consisting of two mechanical air cells in series, making a total of ten cells in the whole plant. That is the cleaner plant as this plant is called. The tailings from this plant is returned to the 75 by 12 foot Dorr thickener and the concentrate goes to our bins and to Portland filter.

X-Q. 122. As finished concentrate?

A. Yes, sir.

X-Q. 123. Now, in your drawing of the upper part or rougher plant, you draw the emulsifiers just the same as you draw the mechanical air cells?

A. This is just a diagrammatic representation of the plant.

X-Q. 124. As a matter of fact the emulsifiers have no spitzkasten, and the air cells have spitzkastens. That is right?

A. Yes, sir.

X-Q. 125. Are these mechanical cells of the double spitzkasten variety or the single spitzkasten variety?

A. This is a mechanical air, as we call it, it is a double spitzkasten variety.

X-Q. 126. That is to say, each one of these cells consists of a separate agitation chamber, a spitzkasten at one side and another spitzkasten at the other side and then on each of these spitzkastens there is

Thomas A. Janney.

a sort of false bottom, with a canvas bottom, and compressed air is forced in, is that right?

A. Yes, practically.

X-Q. 127. And that runs on all through the plant?

A. Yes, sir.

X-Q. 128. Everything there is mechanical air?

A. Yes, sir.

X-Q. 129. Now, in your experiments in the slime flotation plant as stated in your table exhibit 32, you have a series of numbered experiments and you have not identified them by the dates and durations of the experiments, although I had you do that as to the others. Will you supply that information now?

A. I haven't the data right here at present.

X-Q. 130. Please obtain the data and let me have it.

A. The duration is given on there.

X-Q. 131. The duration is given but not the succession?

A. That is the time of the test?

X-Q. 132. The data as to the shifts, if you have that, because they are nearly all one shift and some of them half shift operations?

A. I will do that.

X-Q. 133. And then there was a little doubt in your mind as to what shift some one of the experiments in the vanner concentrate plant occurred in. If you can supply that also, please do so?

A. Yes, sir.

Thomas A. Janney.

RE-DIRECT EXAMINATION

BY MR. SCOTT:

R-Q. 134. How much oil per ton was found on the tailings as shown by this exhibit 220, your report?

A. 20.73 pounds per ton of tailings rejected.

R-Q. 135. Did you observe the appearance of the float formed during this run with 323.78 pounds of oil?

A. I did.

R-Q. 136. Will you describe it and compare it with the float upon other occasions?

A. The froth produced was composed of a mass of air bubbles, minerals, some slime and oil. Had every appearance of a froth produced in our plant with the exception that it was considerably more oily. The oil was very apparent.

RE-CROSS EXAMINATION

BY MR. WILLIAMS:

RX-Q. 137. What you said applies to the bulk of the concentrates as a whole?

A. No, it was that way throughout the whole plant.

RX-Q. 138. It looked all alike in every one of the 13 spitzkastens?

A. No, there was more on the upper cells.

RX-Q. 13~~0~~9. The first cell overflowed a tremendous amount of oil, didn't it?

A. The first five cells seemed to be about the sam

RX-Q. 140. Overflowing great amounts of oil?

A. Yes, sir.

RX-Q. 141. And then as you went down the lir the oil condition diminished?

A. Yes, sir.

RE RE-DIRECT EXAMINATION

BY MR. SCOTT:

R-Q. 142. Was that oil that was overflowing sep arating from the rest of the pulp, or forming a pa of the froth?

A. No, it was all air bubbles.

(WITNESS EXCUSED.)

MR. SCOTT: Mr. Sutherland will be the next wi ness.

MR. GARRISON: If your honor will take the cu tomary recess I think we can save a lot of time. W are not going to require these people to produce all c these assays. We usually take a recess about th time and it will be a very useful one now.

(Whereupon a short recess was taken.)

MR. GARRISON: We will admit without the ne cessity of proof that the statements appearing on ex hibit 220 correctly represents the result of the assay weighing and so forth, which they purport to repr sent. Is that satisfactory, Mr. Scott?

MR. SCOTT: I think so.

David Douglas Punchon.

DAVID DOUGLAS PUNCHON, Called as a witness in behalf of the defendant, being first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 1. State your full name.

A. David Douglas Punchon.

Q. 2. What is your occupation?

A. Flotation foreman, Arthur plant, Garfield, Jtah.

Q. 3. It is your duty I presume to superintend ~~the~~ ie operations of the flotation machines of your company?

A. Yes, sir.

Q. 4. Do you operate both the machines which reat the slimes and also the ones which treat the conentrates and if not, which one?

A. I operate both of them, sir.

Q. 5. Have you ever operated—

A. That is, in saying "operate" I superintend all ie operators, that is during my shift, I don't operate iem personally but I see that they are operated.

Q. 6. Have you ever operated these machines with n oil composed of a mixture of 39 per cent fuel oil, 0 per cent Jones oil, 10 per cent American creosote o. 2, and one per cent Yaryan pine oil?

A. I have, yes, sir.

Q. 7. In the regular operation of the plant?

A. Yes, sir.

Q. 8. And when so operating the plant and wi
that oil have you ever turned the oil supply complet
ly off?

A. What machine do you refer to, the retreati
plant?

Q. 9. Yes, sir.

A. Yes, sir.

Q. 10. I mean the one that retreats the conce
trates.

A. Yes, sir.

Q. 11. You have turned off from the one that r
treats the concentrates?

A. Yes, sir.

Q. 12. And what happens?

MR. GARRISON: This goes in under our gener
objection without the necessity of repeating it.

THE COURT: Yes. What is the object of thi

MR. SCOTT: It is to connect up with that 1.
pounds of oil which was left in during this test and
show what effect it would have.

THE COURT: This is all subject to the gener
objection. Of course it is a standing objection.

MR. SCOTT: What was the effect when yo
turned it off?

A. It would hold the cell in suspension—hold th
mineral bound in the cell in suspension.

Q. 13. And just explain what you mean by that.
don't understand it?

A. That is it will hold the froth up.

Q. 14. Hold it up, you mean just suspend it?

David Douglas Punchon.

A. Suspend it, yes, sir.

Q. 15. Or stop it or what?

A. Just suspend it there. It will lose its action after a very short time. It won't displace for a moment but what it will lose its time there.

Q. 16. After a minute has passed, following the complete shutting off of the oil supply, state whether there will be froth or won't be froth in the spitzkasten?

A. It will gradually die away entirely in the spitzkasten, and cease to have any selective action whatever.

Q. 17. And how long before it dies away?

A. Well, sir, I wouldn't give it accurately, practically—the effect will take perhaps from a minute to five minutes you won't have no froth there.

MR. SCOTT: That is all.

CROSS EXAMINATION

BY MR. WILLIAMS:

X-Q. 18. When did you test this?

A. We have tried this several times in using our judgment on the oils.

X-Q. 19. And what was that under conditions where the circulating load was going around?

A. Yes, sir.

X-Q. 20. That was done under your present operations, using something over twenty pounds of oil to the ton of ore?

A. Yes, sir.

MR. WILLIAMS: That is all.

(WITNESS EXCUSED.)

REX SUTHERLAND, Called as a witness in behalf of the defendant, being first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 1. Please state your full name?

A. Rex Sutherland.

Q. 2. What is your position?

A. Flotation foreman.

Q. 3. Flotation foreman?

A. General flotation foreman.

Q. 4. Over all three shifts?

A. Yes, sir.

Q. 5. Where?

A. Arthur plant.

Q. 6. Mr. Sutherland, Mr. Punchon that just testified is foreman of one shift, isn't he?

A. Yes, sir.

Q. 7. And you are the foreman of the entire three shifts?

A. Yes, sir.

Q. 8. In operating the Arthur flotation plant, have you ever cut off the oil supply when using a mixture composed of 59 per cent fuel oil, 30 per cent Jones oil, 10 per cent American creosote No. 2, and one per cent Yaryan pine oil?

A. Yes, sir.

Q. 9. And what happened when you shut the oil supply completely off?

Rex Sutherland.

A. Why, your froth, you will have your froth just the same for possibly, I should say thirty seconds before you can notice it, in just the ordinary course of operations. Sometimes the elevator will stop and you won't have any oil going in there. Well, the operator will stand and watch that and he will immediately notice his froth die, won't have any agitation in the back and within—if he lets that go, within say three minutes there won't be any froth in the first cell at all.

Q. 10. The first, that is the head cell?

A. Yes.

Q. 11. And how about it down through the line?

A. Well, it takes longer to work down through there, goes right on down through the line.

Q. 12. How long before that condition spreads through the machine?

A. Well, I should say it would take ten minutes to go all through the machine before the froth would entirely disappear.

Q. 13. Well, do these statements that you are making apply to the slime flotation treatment or to the machines that are treating the concentrates?

A. The machines that are treating the concentrates.

Q. 14. The vanner concentrates?

A. Yes, sir.

Rex Sutherland.

CROSS EXAMINATION,

BY MR. WILLIAMS:

X-Q. 15. How recently have you made that sort of a test?

A. Well, we made them as they occur, several times, just in the ordinary course of operations.

X-Q. 16. And during that period in which you have been using more than twenty pounds of oil to the ton of ore?

A. Yes, sir.

X-Q. 17. You spoke of it as a result of the elevator breaking down. I don't quite understand it. Just explain it.

A. Well, something would break in the elevator, something like that.

X-Q. 18. What does the elevator do, the one that breaks under those conditions?

A. Well, that sends the oil into the machine.

X-Q. 19. Sends the ore?

A. The oil.

X-Q. 20. Oh, you have an elevator for oil?

A. Yes, sir.

X-Q. 21. And you were talking of the oil elevator?

A. Yes, sir.

X-Q. 22. And everything else in the plant will be running, middlings returning and so on, they will all be running the same, and when you stop the oil supply what you speak of happens, is that right?

A. Yes, sir.

Samuel P. Sadtler

RE-DIRECT EXAMINATION,

BY MR. SCOTT:

R-Q. 23. Were middlings being returned? Did you have a circulating feed at that time, the time the oil was completely off that you testified about?

A. Yes, sir, during the regular course of operations, we have the middlings returned.

WITNESS EXCUSED.

DR. SAMUEL P. SADTLER, recalled, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 593. Dr. Sadtler, you have heard, have you, the description of these operations at the Arthur plant that Mr. Janney testified about with 323.78 pounds of oil per ton of ore?

A. I heard Mr. Janney's testimony.

Q. 594. Will you compare that operation with the disclosure in each of the following: The Everson patent, the California Journal of Technology, the Kirby patent and Froment, as to the following: I would like a comparison made as to the powdering of the ore, its admixture with water, the addition of oil and agitation?

A. The first in order of these disclosures of course is the Everson patent. In the Everson patent we have

Samuel P. Sadtler

covered first of all on page 1 of the Everson patent as part of the Everson invention: "A fat or an oil either animal, mineral or vegetable." That is broad enough to cover any admixture of oils or fatty oils, essential oils or any constituent or derivative from paraffin, or any mineral oil, irrespective of the question as to whether it may be totally insoluble. We have then the presence of acid, either mineral or vegetable acid used. Now, passing to the process indicated in the Everson patent, we have the second and third steps, as I termed them before, the first step being that operation wherein the acid and the oil were mixed and allowed to stand together for a time before adding that mixture to the oil. I leave that to one side and turn to the second step of the Everson patent in the use of petroleum or a liquid constituent thereof like paraffin oil, and then the third illustration of the Everson patent. It is stated clearly: "It is also not essential to my invention that the acid or salt employed with a vegetable oil be added to the oil before the incorporation of the oil with the ore, as it is entirely practicable, at least in most, and possibly in all, cases, to first mix such oil with the ore and thereafter add the acid, as set forth in the use of petroleum." That makes the method which was described more fully in connection with the use of petroleum available and extended to the use of any of these types of vegetable or animal oils, but at all events to vegetable oils, and that of course includes the fixed oil

P. 3856, L. 8, insert " the essential oil may be in pa
soluble or not," after " whether "

Samuel P. Sadtler

Everson contemplates the operation as described more fully under petroleum as applying there also.

Now, we have in the Everson patent the pulverization of the ore, finely powdered, "the reduction of the quartz or other rock containing the mineral to a powder," reducing the mineral to a comminuted state as described on the first page, and then we have in this second or third process the mixing of the finely powdered or comminuted ore with the oil. Everson gives an example in which 17 per cent was used. That is an example and is not binding, but well known, as I indicated.

Then we have next in the practice the concentration, after thorough agitation of the mass. That is the agitation step, which is applied in a small way or applied in a large way, and was the agitation step of the Utah practice. And the detachment of the sand, which means the separation of the gangue, and next: "Will in this case be preferably removed by means of a constant overflow of water from a washing-out vessel, by which overflow the concentrate will be floated off."

That represents the steps of the process, what takes place on the spitzkasten, and represents the passing off of the froth or of the mineralized ore froth. The amount which was used, as I understood Mr. Janney to say, was 323. and a fraction pounds per ton. That is very close to 16 per cent, 16 per cent of oil or oil mixture practically was used in that case. That is very close to the 17 per cent of Everson and

Samuel P. Sadtler

practically is in the same class of operation with the amount of oil.

Passing next to the Kirby patent, we have in the Kirby patent, coming as late as—his application of December 14, 1903—we have in the Kirby patent the finely pulverized ore or mineral~~ized~~ matter, enough water to make with the same a floating pulp and then either kerosene or "a solution of bitum~~i~~en in a thin distillable hydrocarbon liquid, as kerosene" and these mixed so thoroughly, agitated together so thoroughly "as to finally subdivide said solution into small globules into contact with substantially all of the pulverized mineral particles which will, by preference, adhere to them." And, following that: "In allowing the hydrocarbon-coated particles to float to the surface of the mass." Now, that first step of the Kirby process is the exact counterpart in principle, as I will point out in a minute in some details, with the large scale process ~~proceeds~~ which was carried out and described by Mr. Janney. In the first place, in this Kirby process we have an efficient agitator—agitation shown and with rapid agitation, "Violent agitation" in fact the claims say, in the first or mixing vessel. That is the type of the mixing mechanism which was used in the experiment described by Mr. Janney. At the time of this Kirby application there were mechanisms, as testified before. There were other forms of efficient mixing apparatus known, distinctly two in number, the Johnson mixer and the Gabbett cone mixer. So that there was available a mixing apparatus ex-

P. 3858, L. 13, insert " and bring said globules " after " les "

Samuel P. Sadtler

actly of the same mechanical type as that which was used in the large scale operation at the present time. All of the principles necessary to produce the froth were here indicated as the illustration of efficient agitation.

Turning to the Froment. In the Froment description and the Froment machine we have also a form of agitation which is quite efficient. That is the revolving oval, the oval forms of rotating blades which rotate in opposite directions and thereby create strong or really thorough agitation and entrain air and produce a froth in the presence of the proper amount of oil with the floating pulp and the presence of mineral sulphide particles; this froth is stabilized so that we have the production of an efficient froth as a step shown in that Froment description and the Froment patent in the first of these vessels of the Froment patent, called the mixer in the Froment description, all of the principles are the same there, their production of a froth as in the practice in the large scale. The froth in the case of the Froment description is carried off into a second vessel and there is supplemented by that acid treatment using some calcite, but that is cited as a secondary step and does not bear upon the main feature of the mechanism, and the application of the principles necessary to produce a froth.

In the case of the California Journal of Technology, we have no machinery. We have only the showing of an efficient froth, of getting the foam effect, as

Samuel P. Sadtler

it is called; but in the getting of this foam effect w
have the principle there of the flowing ore pulp an
the small amount of oil, and that was smaller than wa
referred to in this other case, the 17 per cent o
Everson, 25 per cent to 75 per cent of Kirby and th
16 and a fraction per cent as practiced in the Uta
experiment. And then the violent agitation, and wi
these elements which are the same in all of these cas
we get the mineralized froth of the California Journ
of Technology when we used a modern—when we use
a form of mechanical agitator which was howeve
abundantly known at the time of the California publ
cation, that is, the Gabbett cone mixer, which wa
patented in 1889 already, which we used then in th
experiment that still stands there for illustration o
the California Journal of Technology proceedings, w
got a fine froth, mineralized froth.

So that in all four of these publications stated, a
belonging to the prior art, we have a clear statement o
all the principles involved in the raising of a frot
as practiced by Mr. Janney using 323 pounds of o
mixture to the ton of ore, approximately 16 per cen

CROSS EXAMINATION,

BY MR. WILLIAMS:

X-Q. 595. Do you regard this operation by Mr
Janney as the carrying out of what you have discovere
to be the three methods—to be the third method of th
Everson patent?

A. It would come under that clause rather tha

Ben H. Dosenbach.

under the second because his mixture was largely—well, it would be a mixture of oils, oil—all of them covered clearly by Everson in her statement—covered clearly by Everson in her patent. That is as I understand her: He had some fuel oil, had some pine oil and that goes into the two classes of paraffin product and vegetable oil. But as the process described in Everson is equally applicable so stated by Everson, I see no reason why we should not use a mixture.

WITNESS EXCUSED.

BEN H. DOSENBACH, recalled, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. In the Butte & Superior flotation plant is there any difference in the level in the pulp in the roughers and cleaners? Any difference in the point at which the froth is taken off?

A. Yes, there is a difference.

Q. 2. And what is the difference?

A. The level of the pulp in the rougher cells is carried much higher in the spitzkastens than it is in the cleaner. That is the lower portion of the froth is much higher in the spitzkasten in the cleaner than it is in the rougher cells.

Q. 3. And what is the reason of that?

Ben H. Dosenbach.

A. The object being to take off the froth to th cleaners only without any of the pulp, and the objec in the rougher cells being to take off as much as pos sible but not so high a grade, in order to make th recovery.

Q. 4. I would like to have you look at the Calif ornia Journal of Technology a minute and tell me wha you understand by some of the terms. Now, unde that tabulation of experiments which occurred afte the heading "test—molybdenite ore" we find the firs paragraph relating to tests 1, 2 and 3, then the nex paragraph relating to test 4, 5 and 6, and the state ment is made: "This method gives the highest grad of concentrate of any of the direct treatment here out lined." The word, "direct" I wish to call your at tention to that. Then, in the following paragraph "But these concentrates were not marketable. In prac tice they would have to be reconcentrated" and th word "reconcentrated" and then one of the column in the table above is headed "number of treatments. Now, I would like to know your understanding as metallurgist of the significance of that term "numbe of treatments" at the head of that column, and o the word "reconcentrated" and the word "direct"?

MR. WILLIAMS: I object to the testimony o this witness in explanation of the column headed "num ber of treatments" because he has not qualified, eithe by a study of the document as a whole or by knowl edge of the meaning of terms in the days of this in vention so as to enable him to testify as to what thi

Ben H. Dosenbach.

neans. So far as the meaning of the word "re-concentrate" and I think something else is concerned, see no particular objection to that, but it seems o me the witness has not qualified to express an opinon on this matter.

MR. SCOTT: Maybe I can qualify him.

Q. 5. Have you studied this article in the California Journal of Technology?

A. I have.

Q. 6. Have you performed operations that you conidered to be in conformity with the directions conained in that article?

A. I have.

Q. 7. I think you qualified before as to your scienific education and experience, did you not?

A. I did.

MR. SCOTT: I submit, your honor, that with the ualification of this witness he is in a position to impart information to the court and ourselves as to the neaning of technical terms.

THE COURT: Well, is there any difference beween the way these terms were used in that day and his?

MR. SCOTT: I know of no difference.

MR. WILLIAMS: I don't believe the witness does. That is the difficulty.

MR. SCOTT: Well, the test is as to his undertanding of these words.

MR. WILLIAMS: His knowledge commenced in 906.

Ben H. Dosenbach.

MR. SCOTT: Well, the article was written in 1903.

THE COURT: Well, the presumption runs forward a little I consider so now it may run backwards a little. I will allow him to answer. The objection will be overruled.

A. Experiments Nos. 4, 5 and 6 as stated in this article show the results obtained by treating separate samples with small quantities of oil and in a small solution, agitated violently to produce the foam effect. Now, this article says this method gives the highest grade concentrate of any of the direct treatment here outlined. I would say that means that it is a comparison of the results obtained between the three experiments when a small quantity of oil was used. Then further along in the experiment No. 6, 10 c.c. of oil was used for 100 gms. of ore. It states the recovery as being 75 per cent and the concentrate 32.4 molybdenum sulphide. It also states that the concentrates were not marketable; in practice they would have to be reconcentrated. That means that the concentrate produced by the initial treatments were not of sufficient value to be marketable and would have to be retreated again in order to obtain a proper grade Consequently the description of a retreatment of the concentrates follows in the next paragraph.

Q. 7½. Well, with this—would this reconcentration referred to here correspond to what you call "cleaning"?

P. 3864, L. 16, insert " large quantity of oil was used and the three experiments when a " after " a "

Ben H. Dosenbach.

A. Yes, it would correspond to what we call cleaning.

Q. 8. Now you did not tell us your understanding of the head of that column, "Number of Treatments."

A. I was just going to. In the fifth column, under the head "Molybdenite," setting forth the various steps in the experiment that were performed, the heading of the fifth column is abbreviated but I take it to mean number of treatments. I should say that the number of treatments in this column means the number of times the process was carried out and the number of times the concentrate was removed, which corresponds directly to the operations in flotation, wherein a number of cells are used to constitute a flotation unit.

Q. 9. Do you remember, or did you make a record of the speed of the revolutions of this Fryer Hill machine in which you made a demonstration in court the other day?

A. I think I stated the speed.

Q. 10. Do you remember it now; I don't remember whether you stated it or not.

A. From fourteen to fifteen hundred I think it was; I am not positive without looking over the record for that day.

Q. 11. In the Butte & Superior plant I think the witnesses have stated that sulphuric acid is used. Will you state where that is added to the pulp?

A. In practically all of the operations the acid is usually added to the feed before it enters the flo-

Ben H. Dosenbach.

tation plant; that is, there is a time which elapses between the time the acid is added to the feed going to the flotation plant and when the feed enters the flotation plant.

Q. 12. How much time do you suppose; a matter of minutes or hours?

A. Well, it might be minutes and it might be hours, all depending on the circuit. I should say it would be possibly fifteen or twenty minutes.

CROSS EXAMINATION,

BY MR. WILLIAMS:

X-Q. 13. In the California Journal of Technology as I understand it, the operations were carried on, as far as molybdenite ore was concerned, in percolating tubes, weren't they?

A. They were.

X-Q. 14. Do you understand what the number of treatment means as applied to those experiments, that were clearly Elmore experiments, Nos. 1, 2 and 3?

A. I would take them to be the same as the other experiments following, 4, 5 and 6.

X-Q. 15. They also were carried on in the Elmore process in these percolating tubes. Tell me what the procedure was.

A. The oil may have been taken off; I don't know the method.

X-Q. 16. Start at the beginning.

A. Beginning on page 35 of this article it gives the conditions of the various experiments that follow,

Ben H. Dosenbach.

nd it gives the laboratory method for conducting he tests. There are two different ways of mixing, which is stated on page 36. One is by agitation, thorough agitation, and the other is by very gentle agitation, the oil being kept in a single lake and broken p as little as possible consistent with a thorough ontact of the pulp and oil, which describes the Elmore procedure, and the following describes the agitation and formation of a froth procedure which states hat—It states that each method has its advantages nd disadvantages. Now it says, directly following hat: "The mineral laden oil was then skimmed off vith an aluminum ladle." And it goes on to state why aluminum was used and the comparison between luminum and glass, and I take that to be an accurate escription of how the mineral laden oil was removed. t says it was skimmed off with an aluminum ladle, nd down below in this table that I was referring to, t says "Number of Treatments." So consequently I vould take it that it was treated again.

X-Q. 17. As you read it there it says "The mineral aden oil is then heated and treated in the centrifugal eparator as above described." Does it not?

A. That is a correct reading of one of the paragraphs of this page, yes.

X-Q. 18. And that immediately follows a repetition f that description of the methods of agitation, one y inverting the tube, two by rotating the tube, three y violently shaking the tube; and then the statement hat the charge having been thoroughly mixed, the

Ben H. Dosenbach.

tailings were allowed to settle, the solution is added through the oil on top of the tube, the concentrate being floated off as shown in Figure 26. That is right, isn't it?

A. No, that paragraph describes three methods of mixing by agitation, because there is one which is inverting the tube several times, and another by rotating the tube and another by violently shaking, which is differentiated some from the first two.

X-Q. 19. But that paragraph describes just three methods of mixing?

A. Yes.

X-Q 20. Then it proceeds to tell you what is done after the mixing, doesn't it?

A. Yes.

X-Q. 21. And we find the mineral laden oil is heated and treated in a centrifugal separator. Isn't it reasonable to assume that the men who described these experiments told you what they did, and that when they say they do something, that they did do it, therefore, that they did it by those three methods?

A. No, I could not interpret it that way.

X-Q. 22. Now, let us return to the table itself. The first, No. 1, we have 2400 grams of oil and 2000 groms of ore; that is the largest aomunt of oil of all of the experiments isn't it?

A. Yes.

X-Q. 23. Now, we find there were four treatments; now you know that in the Elmore process that is just what they do, and that is what these men say they

Ben H. Dosenbach.

did; they take the concentrate, float it off, and treat it in a centrifugal separator, and separate the oil, and then they put the oil back again and see what more they can do with it; isn't that right?

A. In the Elmore, yes.

X-Q. 24. And they have succeeded by that means in getting four different treatments; that is a reasonable interpretation of what it means, isn't it?

A. Yes.

X-Q. 25. The next column we have 2000 grams of oil and 2000 grams of ore; that is a little less oil, and they only got three treatments. That would be treatments of the kind that they have spoken of here, would they not?

A. They would.

X-Q. 26. The kind I have mentioned?

A. Yes.

X-Q. 27. The last one of the Elmore, we have a thousand grams of ore and 1200 grams of oil, and there there are three treatments. That would be the same kind of retreatments I have described here, would they not?

A. They would.

X-Q. 28. And now we go down to experiment No. 4, where there was 2.4% of oil, and there was only one treatment. That would indicate, would it not, that they were not able to get enough oil out of it to start over again?

A. No, I don't say that that would indicate that they could not get enough oil out of it, because the

next one follows with two treatments, and the next one with three.

X-Q. 29. And that second one had twice as much oil—more than twice as much?

A. Yes, it had.

X-Q. 30. And the next one had almost three times as much oil, or a little more than three times as much oil, 8.9%, and there you get three treatments; now, isn't it reasonable to assume that since the number of treatments correspond with the amount of oil, that the students did the same thing with their smaller quantities of oil that they did with their larger quantities of oil?

A. I can not conceive how they could get the oil out of the concentrate on that experiment No. 4, wherein 2.1% of oil was used, and I agree with you that if there was not enough oil when they were using 2.1% to get it out, then they did not make any more treatments because the oil was not perceptible, possibly.

X-Q. 31. Your theory as I understand it was, that they shook the ore and oil in a percolating tube and took off the concentrate, and then they shook it again in the percolating tube and took off the concentrate, and then they shook it again; is that your theory?

A. That is not specifically stated, that they did that; it might have been according to your theory of adding more oil, and it might have been that they shake it over and over again. It can be taken both

Ben H. Dosenbach.

ways in this. And even if it was with more oil, it shows the betterment of the recovery.

X-Q. 32. A reasonable interpretation of that would be that in the 5.3% experiment where they had two treatments, that they agitated the tube, formed the froth, and then added the same kind of oil and agitated again and took off that froth; that would be the two treatments on your theory?

A. That is one way according to my theory; the other way is that they agitated once and took off the froth, and agitated again and took off the froth; that is one way that they might have carried out the operation, and the other way that they might have carried out the operation.

X-Q. 33. As a matter of fact you are not certain what those students meant when they were writing this description of their laboratory operations with nothing before them except the Elmore process to guide them: that is true, isn't it?

A. Well, they had the Everson; they stated back here that they had the Everson to guide them in a way.

X-Q. 34. You notice that they do not speak of the Everson as a frothing process, don't you?

A. They speak of the Everson as bringing forth the use of acid, and give her credit for the use of acid in the processes of separation. Then they themselves, I think, must be given a great deal of credit for froth flotation, because they mention the word froth, and they mention agitation, and float, and I can not see any other way but what they themselves must be given a

great deal of credit for the production of a mineral froth.

X-Q. 35. I am not discrediting the ingenuity of the students, but I am trying to make out whether you can be sure as to what they meant when they said the number of treatments, 1; number of treatments, 2; number of treatments, 3, in this printed document. You are not sure whether in their treatments they added oil or whether they omitted to add oil, are you?

A. I am not sure about that; as I stated before, it can be taken both ways. If there was sufficient oil present that they could obtain from the concentrate to put back again into the next agitation procedure, then that operation could be carried on that way. If that was not possible, they did not do it that way.

X-Q. 36. But you can not be certain as to what my interpretation of it is.

X-Q. 37. And you don't know which one they did?

A. Which one of them, that may be correct.

X-Q. 38. Now, you were to let me have a flow sheet of the Bute & Superior mill as it was operated in the presence of the plaintiff's representatives.

A. I have prepared a flow sheet for you, Mr. Williams, according to that.

X-Q. 39. Suppose you describe it as briefly and clearly as you can.

A. The flow sheet as represented upon this tracing, is very similar to the one previously described by me in court, with the exceptions that there are several changes, which I will note. On Sunday, April 29th,

P. 3872, L. 17, insert " which way they did it ? A. I give two statements " after " certain "

Ben H. Dosenbach.

there were seven pyramid roughing cells in operation, which are numbers 1, 2, 3, 4, 5, 6 and 7. The number 8 pyramid machine was in operation as a cleaner unit, and was used to clean the concentrate from No. 1 cleaner, which is this cleaner that I am now referring to. Now, the four middling cells on one side of the pyramid machine, or on one side of the agitating cells were blocked off, so that none of the froth was taken off in those spitzkasten. That is what occurred for all of the pyramids with the exception of No. 5. No. 5 was open on both sides; it shows here to be closed, but I have just made several crosses here and notation, denoting that these four cells were open in this pyramid machine.

X-Q. 40. When you say blocked off, you mean the entrance to them was closed so that no liquid could get into them?

A. The duct from the agitating cells to the spitzkasten was closed, so that there was no circulation or no pulp flowing through these four spitzkasten. That was the condition of the pyramids, as I have said, with the exception of No. 5 pyramid. Now, the flow through the plant was substantially as described before, with the exception that of the middling cells, which constitute four of the later pyramids—

X-Q. 41. The last four?

A. The last four of the pyramid cells—it was only taken off on one side. This cleaner, which we will call No. 1 cleaner, was the first cleaner, and to it was brought the rougher concentrate produced by the first three cells of the pyramid machine. The concentrate

Ben H. Dosenbach.

from No. 1 cleaner was pumped up to No. 2 cleaner, producing on the first three cells a second cleaner concentrate, which was elevated to No. 3 cleaner, which produced a final concentrate. The last four cells on one side of the second cleaner produced a lower grade concentrate, which went to the No. 1 cleaner, and again through the circuit up to No. 2 cleaner. The tailing from No. 1 cleaner went back as a middling. The tailing from No. 2 cleaner went out to waste as a discarded product. The tailing from No. 3 cleaner went back to No. 2.

X-Q. 42. Now, these cells, 4, 5, 6 and 7 of the No. 2 cleaner, were they provided with the pneumatic attachment that characterizes what is known as the Janney mechanical pneumatic machine?

A. They were.

X-Q. 43. That is true of course; ~~they are~~ of all the pyramid machines.

A. In all of the pyramid machines the last four are provided with the pneumatic equipment.

X-Q. 44. Now, in the operation of No. 2 cleaner the pulp flowed successively to it from spitzkasten to spitzkasten in the usual way?

A. It did.

X-Q. 45. And of course in your pyramid machines, they flow down by gravity?

A. They do.

X-Q. 46. From spitzkasten to spitskasten?

A. Yes.

X-Q. 47. Now, in the No. 1 cleaner, did the material

P. 3874, L. 5, insert "The No. 3 cleaner produced a finished concentrate" after "concentrate."

Ben H. Dosenbach.

treated flow from spitzkasten to spitzkasten in series?

A. There is practically only one spitzkasten for that cleaner.

X-Q. 48. That is to say the partitions between the spitzkasten do not extend down very far, do they?

A. They do not.

X-Q. 49. How far do they extend down below the top?

A. About ten or twelve inches.

X-Q. 50. Then below that on both sides it is all one large spitzkasten, is that right?

A. Yes.

X-Q. 51. Then No. 2 agitator for No. 1 cleaner, where does it draw its supply of material to be agitated?

A. From the spitzkasten.

X-Q. 5~~1~~2. And that is true all along the line there?

A. It is.

X-Q. 53. How about No. 3 cleaner?

A. That is the same as No. 1 cleaner.

X-Q. 54. Then in the No. 3 cleaner the spitzkasten are entirely separate in each cell—the spitzkasten for each cell is sepaarted from the spitzkasten for the other cells?

A. No, it is just like No. 1.

X-Q. 55. That is to say, it is all one general spitzkasten?

A. Yes.

X-Q. 56. Now, was that arrangement an arrangement made on that day, or how long had it continued?

A. That had been made for—that had been running

Ben H. Dosenbach.

that way for—well, the last time I was up to the plant was several days before then, and it was running then, but I did not give it any general inspection because I was busy down here; but we have run this many times like that before, and it has been arranged several months ago to use this No. 8 pyramid as a cleaner. There was no special arrangement made for any part of the operation on Sunday.

X-Q. 57. In your No. 2 cleaner, and I think in all your pyramid machines, I observed a substantial difference in the top of the spitzkasten between the cells Nos. 1, 2 and 3 and Nos. 4, 5, 6 and 7. Suppose you describe that difference.

A. Well, that is due to the fact that the spitzkasten of cells No. 1, 2 and 3 are deeper than the spitzkasten for 4, 5, 6 and 7, and the construction was placed that way.

X-Q. 58. You have not described it.

A. The first three cels are mechanically agitated only. The last four cells are mechanical and air, consequently it is not necessary to have as deep a spitzkasten for mechanical and air as it is for straight mechanical.

X-Q. 59. I notice that your flow was restricted as it came out of cells 4, 5, 6 and 7; that the sides of the top of the spitzkasten approach together so that the overflow was quite restricted; that is the construction, is it not?

A. It is.

X-Q. 60. Whereas in 1, 2 and 3, they are of the full

Ben H. Dosenbach.

vidth throughout and the overflow lip was the full vidth of the spitzkasten?

A. That is correct?

X-Q. 61. Then in cells 1, 2 and 3 you have a me- hanical arrangement somewhat resembling a paddle for ushing the concentrate over the lip?

A. That is correct.

X-Q. 62. And in cells 4, 5, 6 and 7 it rushed off the estricted lips without any assistance?

A. That is right.

X-Q. 63. Now, you used your mechanical arrange- nent for pushing the concentrate over the lips in Nos. and No. 3 cleaner, do you not?

A. That is correct.

X-Q. 64. Can you tell me why it ~~that~~ is that the spitz- asten for all the pyramids except No. 5 were put out of action?

A. That was done to relieve the elevators, and to educe the middling that was returned back for circula- ion and retreatment. It reduced the load approxi- nately one-half.

X-Q. 65. Now, as this plant was operated on Sun- lay in our presence, what was the place of the oil feed of the plant; is that shown?

A. It is shown substantially the same as on my previous flow sheet.

X-Q. 66. Marked "oil feed"?

A. Marked "oil feed."

X-Q. 67. And that—at that oil feed the oil was fed in hot, was it not?

Ben H. Dosenbach.

A. Well, I should say warm; warm enough to keep it plenty liquid.

X-Q. 68. You have a steam heating arrangement in your oil mixer, have you not?

A. It is absolutely necessary, yes, sir.

X-Q. 69. Have you any figures as to the temperature at which the oil goes into the plant?

A. I have not, off-hand, no.

X-Q. 70. And the water as it flows through the plant is quite cold, is it not, and you do not heat that at all?

A. We take the chill off of it at times.

X-Q. 71. You were not on Sunday last taking the chill off of it?

A. I don't remember what the temperature was Sunday; it might have been about 14 or 16 or 18 degrees. We don't make any particular effort to heat it or not heat it, only on cold nights we can not allow the cold water to run through.

X-Q. 72. You don't want it to freeze?

A. No, I should say not.

X-Q. 73. Therefore you guard against freezing?

A. Yes.

X-Q. 74. Have you got with you the mill reports of operations of the plant on Saturday the 28th, Sunday the 29th and Monday the 30th of April?

A. No, I haven't brought those with me.

X-Q. 75. Will you bring those reports—I believe I asked you to bring some other reports, did I not?

A. Yes.

Ben H. Dosenbach.

X-Q. 76. Have you them with you?

A. Yes. I might say that these reports of the oper-tion on Sunday are being prepared and I think will be inished some time tonight; and possibly the men who re preparing them now will have them finished in time o submit them tomorrow.

X-Q. 77. Could you include the day before and the ay after?

A. I will do so if you desire.

MR. SCOTT: I offer the flow sheet in evidence roduced by the witness, as representing the operations n Sunday, April 29th, 1917.

Flow sheet admitted in evidence marked DEFENDANT'S EXHIBIT No. 222.

X-Q. 78. What are these records which you have rought and are now exhibiting; when do they commence?

A. They commence prior to September 30th, 1913, nd as I understand it you wished some one day, November 1st, 1913, or October 1st?

X-Q. 79. Well, let us take September 30th, 1913. Give me the ore milled, what is that figure?

A. The ore milled on September 30th, 1913, was ,308 tons.

X-Q. 80. And that was the total amount of ore nilled in the plant, was it?

A. That was the total amount of ore milled in the ntire mill.

X-Q. 81. So that a part of that ore went through the water concentration, and some concentrate was taken

Ben H. Dosenbach.

off, and the balance of it went to your flotation plant, is that right?

A. Exactly so.

X-Q. 82. Now, give me the amount and grade of concentrates in the wet concentration plant for that day.

A. It is impossible to give it to you for that day, because I have no record of it. I have a record of the assays, but as to the amount, I can not differentiate from what is produced in the flotation, only an estimate; but the average zinc concentrate I can give you.

X-Q. 83. What is the zinc produced in, tons; is that the total of the plant?

A. Yes.

X-Q. 84. How much is it?

A. 505 tons.

X-Q. 85. And the lead concentrate produced?

A. Six tons.

X-Q. 86. General heads, moisture percentage?

A. 2.0%.

X-Q. 87. General head, lead?

A. 1.2%.

X-Q. 88. General head, zinc?

A. 21.9%.

X-Q. 89. General tails, lead?

A. .18%.

X-Q. 90. General tails, zinc?

A. 4.1%.

X-Q. 91. Zinc concentrate, lead?

A. 1.9%.

X-Q. 92. Zinc concentrate, zinc?

Ben H. Dosenbach.

A. 50.3%.

X-Q. 93: Lead concentrate, lead?

A. 48.4%.

X-Q. 94. Lead concentrate, zinc?

A. 17.2%.

X-Q. 95. Indicated recovery?

A. 88.59%.

X-Q. 96. Apparent extraction, zinc?

A. 88.50%.

X-Q. 97. The item of estimated recovery is not filled in under the day; is that right?

A. That is right; it is not filled in for the particular day, as we keep the apparent estimated recovery up to date, for the whole month, to date, from day to day.

X-Q. 98. Give me the figures of the flotation output in shifts.

A. The flotation concentrate assay by shifts was for the first shift, 49.5% zinc; for the second shift, 48.3 zinc; for the third shift, 50.8% zinc.

X-Q. 99. And isn't there a separate figure for the water concentrate?

A. Yes.

X-Q. 100. Read that.

A. The zinc produced in the water concentration end of the mill for the first shift assayed 52.3% zinc; for the second shift, 51.8% zinc; for the third shift, 50.6% zinc.

X-Q. 101. Is the total of the concentrates given?

A. No, only as a total, the combined flotation and mill zinc?

Ben H. Dosenbach.

X-Q. 102. What is that?

A. 505 tons.

X-Q. 103. Now the amount of oil used, read that by shifts.

A. I haven't got it by shifts, but the oil used on that day was—I don't know whether that figure is right or not; it says 13.79 pounds of oil per ton.

X-Q. 104. BY THE COURT: Was that after Devember 26th?

A. No, this was September 30th, 1913. It says on that report that there was 18,044 pounds of oil used that day.

X-Q. 105. Let's see how many were used the next day.

A. Well, the day previous, I see the report says there was 1,742 pounds used.

X-Q. 106. And the percentage of that was what?

A. 1.676 lbs. per ton.

X-Q. 107. Take the day ahead, September 28th.

A. The amount of oil used on the 28th was 1,800 lbs., or 1.751 lbs. per ton.

X-Q. 108. Aren't you inclined to believe that there is a mistake in the return for September 30th, 1913?

A. Well, I have not looked at this thing for a long while, and I just got these reports out.

X-Q. 109. I will ask you to check it up over night, if you will.

A. Very well.

MR. SCOTT: If the court please, I would like to have the record show that we invite plaintiff's repre-

Ben H. Dosenbach.

sentatives to witness a repetition of the test with 323 lbs. of oil, that Mr. Janney testified to, and we will be willing to do it on Sunday next or any other Sunday or any other time that will be suitable and agreeable.

MR. GARRISON: At your plant here?

MR. SCOTT: At Salt Lake City, or at Garfield.

MR. GARRISON: Oh, no, that is unreasonable.

THE COURT: The record may show it; I don't know how much weight we will attach to that kind of an offer. It might be in Alaska next time.

MR. KREMER: If your honor please, I have got here the answer to the plaintiff's bill as amended, and I have also an answer to the supplemental bill of complaint. Under the rule, notice was given by counsel that the portion of the amendment as embodied in the application to file the supplemental and amended bill, was noticed to become a part of the original bill, and under the rule, giving page and line; therefore it automatically became incorporated in the bill as amended. For that reason we have prepared a separate answer to the original bill as amended. That left the supplemental bill, having expunged from it paragraph 8, that having become a part of the original bill, and we now file an answer to that. In this connection I will state to the court that we expect to close our case tomorrow, and I have endeavored to have these answered prepared—I asked your honor if we had all day tomorrow, but I thought it better to have them prepared so that counsel would have them before we close our case. They have very kindly consented that if there is any mistake in the

transcribing from the original pleadings heretofore filed, that we may have permission to make corrections of those things.

MR. WILLIAMS: Yes.

MR. KREMER: I thought it would be better to give them an opportunity to examine them over night, before we close our case.

> Whereupon further hearing was adjourned until Saturday morning, May 5th, 1917, 10 o'clock a. m.

Saturday, May 5, 1917, 10 a. m.

MR. DOSENBACH

CROSS-EXAMINATION RESUMED

BY MR. WILLIAMS:

X-Q. 110. At the close of the session yesterday you observed that the record for September, 1913, seemed to contain an unusual amount of oil, and I asked you to check that up over night. What have you learned in regard to that?

A. As far as I could get any more information on that matter—I endeavored to find out just why there was a difference between the 30th and the 2~~8~~9th in the amount of oil per ton of ore, and the only thing that I could find was, it being the last day of the month. I could not find any records wherein it showed any real

Ben H. Dosenbach.

reason for its not being what it is, other than the last day of the month.

X-Q. 111. That is to say, a sort of accumulation of the errors of the month, to check up the total month's consumption?

A. Yes.

X-Q. 112. Let us have, then, the average for the month.

A. The average for the month was 2.799 lbs. per ton of ore milled.

X-Q. 113. Does this record show the character of the oil?

A. This record does not show the character of the oil.

X-Q. 114. Now, turn back to the last day of August. What was the record on that day as to oil used per ton of ore milled?

A. The record for August 31st, 1913, shows 2.561 pounds of oil per ton of ore milled.

X-Q. 115. And the record for the preceding day, August 30th, 1913?

A. It shows 1.237 pounds of oil per ton of ore milled.

X-Q. 116. On the date ahead of that?

A. 2.470 pounds per ton of ore milled.

X-Q. 117. I notice that on September 30th there is no acid determination; what does that mean?

A. Well, there was possibly some reason for it; I don't know what the reason might be. It is not on here for September 30th.

Ben H. Dosenbach.

X-Q. 118. But for September 29th you have an acid determination?

A. Yes.

X-Q. 119. What is the proportion of acid?

A. The amount of acid is 8.065 pounds per ton of ore milled.

X-Q. 120. Now, on August 31st, 1913, what was the acid?

A. 2.139 pounds per ton of ore milled.

X-Q. 121. August 30th?

A. 7.364 pounds per ton of ore milled.

X-Q. 122. And the average for the month of August was 5.816 pounds per ton of ore milled.

X-Q. 123. Now, you have said that the record does not show the character of oil that was used then, but I believe you are acquainted with the fact, are you not?

A. I think I have stated before that during this period two oils were used, the pine oil and oleic acid.

X-Q. 124. In August, 1913, you have an item "Copperas, Pounds, and Lime." That is the sum total of the copper sulphate and lime used?

A. No, that is lime only. This was not scratched out. We used no copperas then.

X-Q. 125. What was the amount?

A. The lime used was .373 pounds per ton of ore milled.

X-Q. 126. August 29th, I see also is it copperas, pounds, and lime.

A. Well, it is lime only, because we did not use any copperas then; it was lime.

Ben H. Dosenbach.

X-Q. 127. And the amount?

A. .363 pounds per ton.

X-Q. 128. THE COURT: How long did you testify that the conditions of this flow sheet you exhibited had prevailed?

A. The one I testified to yesterday?

X-Q. 129. THE COURT: Yes.

A. Why, that has prevailed for the last two or three months. Previous to that, while the machines were of different construction and differently placed as to the relation of one cell to another, there being three machines before and eight machines now, however the three machines had a greater number of cells than each one of the eight has now; but they were the same machines that had been in use before only arranged differently as to the position of one to the other.

X-Q. 130. MR. WILLIAMS: Now, have you the reports of the operations on Sunday, April 28th?

A. Mr. Shimmin has the reports for that and he was to be here at ten o'clock this morning.

X-Q. 131. And you haven't them?

A. No, I haven't them; I haven't had time to make them up personally.

X-Q. 132. I asked you for an analysis of the copper sulphate that you received from the Anaconda Company, have you that?

A. I think I have that in my notes upstairs, in one of my notebooks. I did not remember that I was to furnish that, but it will take only a minute to give it to you.

X-Q. 133. You were to give me an early analysis of

Ben H. Dosenbach.

the zinc in the total feed to the plant, including the circulating load. Have you that?

A. As I remember you asked me for December and November, 1916, and also for December, 1915, so I wish to say that the average for the month of December, 1915, showed 12.16 per cent zinc.

X-Q. 134. And this was the amount of zinc in the total feed, including the new feed in the circulating load, is that right?

A. That is right. Then for November, 1916, the amount of zinc in the feed, including the middlings, was 11.9 per cent zinc.

X-Q. 135. And for December, 1916?

A. The amount of zinc in the flotation feed, including the middlings, was 12.5 per cent zinc.

X-Q. 136. And as to all three of these months the variation up and down from that average was very slight.

A. It was.

X-Q. 137. You were to give me an analysis of the molybdenite ore that you used in the experiment in court. Have you that?

A. I haven't them, Mr. Williams, because it has not been finished yet.

X-Q. 138. Now, in regard to September 30th, 1915, is there any showing on the record of the temperature in the flotation plant?

A. On December 30th?

X-Q. 139. September 30th, 1915?

A. No. And to get that I can give you approximate-

Ben H. Dosenbach.

ly the temperature which we were operating at that time.

X-Q. 140. What was it?

A. About thirty to forty degrees centigrade, somewhere along in there.

X-Q. 141. And when was the introduction of heat or the heating of the pulp eliminated?

A. We eliminated it quite a number of times, but we always kept a little steam there to take the chill off the water, especially in the winter time. But up to 1915, the middle of 1915, say, we used more steam than we did after that time.

X-Q. 142. Well, what were the temperatures prevailing in the plant in December, 1916, before December 22nd, 1916?

A. Before the 22nd of December, 1916, the temperature was about 35° or 36° C.

X-Q. 143. Now, since December 22nd, 1916, what have been the temperatures of the pulp?

A. From 14 to 40° I should say, but at the present time averages close to 14 and 18 degrees; closer to that than the higher temperature.

X-Q. 144. Was there any particular reason for so large a range of temperature?

A. The only reason was that we tried out a high temperature at various times and a low temperature at various times and found it was not necessary to use any higher temperature than we were using.

X-Q. 145. So that you have come down to this low temperature of fourteen or fifteen degrees centigrade as the best temperature to work at?

A. Well, at this time, yes.

X-Q. 146. What methods are used at your plant for the determination of the amount or character of oil in the different products?

A. Well, I am not in a position to state myself what analytical methods are used for that determination. We have an oil chemist who looks after all of those details and I cannot myself state just exactly what he does. However, in a general way, he uses a distillate fraction method of determining certain oils and also the centrifuge and other apparatus for determining other oils in the mixture.

X-Q. 147. What was the general plan and object of determining all of the oil, dissolved and undissolved in the wet analysis that attached to the products?

A. Well, we determine all of the oil that is in the product. The sample of the material goes to the oil chemist in a wet state and he receives it in a wet state and determines all of the oil that is present, and makes his determination relative to the amount of dry material.

X-Q. 148. Where did you purchase the kerosene which was used in the plant on April 29th?

A. I would have to look that up to be exact about it, but we purchased most of our kerosene from the Continental and Salt Lake, Utah.

X-Q. 149. When you receive this kerosene, do you give it any treatment or do you add anything to it before you mix it with the other oils?

A. We do not attempt to add anything to it or

Ben H. Dosenbach.

give it any treatment before we mix it with the other oils. Sometimes we have no tanks available and we have to use a tank that has contained other oils, but then that is very seldom. It is quite a hard problem to take care of all these different oils that come in and it is necessary sometimes to put the kerosene as well as other oils into tanks that have contained different oils.

X-Q. 150. But nothing is mixed with that kerosene or added to that kerosene except the other oils with which it is used, is that right?

A. Nothing that I know of is mixed, and I think I would know of it if there was.

X-Q. 151. Now, was the kerosene that Mr. Phillips used in his experiments the same as the kerosene which was used at the plant?

A. Practically so, yes.

X-Q. 152. What difference is there?

A. I don't know of any difference. Might be a little difference in the small sample he used as compared to the large sample up there.

X-Q. 153. Was there anything put into it?

A. There was not, to my knowledge.

X-Q. 154. Where did the laboratory sample used by Mr. Phillips come from?

A. It came from the stock bottle in the stock supply at the plant.

X-Q. 155. And so far as you know, the oil that Mr. Phillips used, the kerosene, was the same kerosene that was used in the plant?

Ben H. Dosenbach.

A. Well, I may make that statement this way: that so far as I know the kerosene that Mr. Phillips used was practically the same kerosene that I used in my tests here in which I used kerosene, in court, and as to being the same as we use at the plant, it is supposed to be the same but there may be a little change due to age or something like that. It may be a little older sample, but as to anything being put into it or it being contaminated in any way with other oils, that, so far as I know, it is not so.

X-Q. 156. And the oil that you used here was oil obtained from the supply at the plant?

A. Yes.

X-Q. 157. Now, do you remember anything else that I asked you to bring and have not asked you about?

A. Yes, you asked for some detailed information as to the month of February.

X-Q. 158. Will you supply that now?

A. I will be glad to. I think you will find everything on this report that is necessary.

X-Q. 159. This is a full statement of the different days' proceedings in the month of February, 1917, is that right?

A. That is correct, as far as the flotation plant is concerned.

X-Q. 160. And was this prepared by you from the original records?

A. Yes.

Ben H. Dosenbach.

X-Q. 161. And these remarks, were they taken from the record?

A. Yes, they were taken from the record. That was for my own information. I found them there and copied them.

MR. SCOTT: We offer the report produced by the witness in evidence, entitled "Butte & Superior Mining Company, Flotation Plant Operations for Month of February, 1917," this being a statement of the operation for each individual day.

Table admitted marked DEFENDANT'S EXHIBIT No. 223.

X-Q. 162. Is there anything else that I asked you for that you have not supplied?

A. Not that I remember. You asked for the flow sheet, and for a report from February 4th to 28th, but that is included in this report for February. I would like to say, though, that in giving you the amount of oil used per ton in September, 1913, and other days along in that period which I have taken from this daily general mill record, that is the amount of oil used per ton of ore milled, and not per ton of flotation feed. It is based on the actual tons of ore milled.

X-Q. 163. But the difference in the figures would not be very great, would it, between the total ore milled and the new feed to the flotation plant?

A. It would not be very great, no, so it would not make a great deal of difference in the amount of oil to the flotation plant. I just wished to correct that

statement, though, in case it was misunderstood.

X-Q. 164. Well, what would the average difference be in points?

A. I can give you a rough average of that; it would possibly make between five and seven per cent. difference, or a little greater; that is, the amount itself, if it was 1½%, for instance, it would be 5% off the 1½%.

X-Q. 165. Now, in this table that you have produced, exhibit 223, you have not included the total of the concentrates, and you have not included the total of the new feed?

A. Yes, that is included in the table that I have presented, another table before this, which gives the total of flotation feed, the tonnage of flotation concentrates for each one of those days for the month of February.

X-Q. 166. I notice that in this exhibit 223 there is a repeated statement of considerable trouble with the elevator. What was the cause of that trouble and what was it?

A. Well, it might have been due to many things. The trouble with the elevator possibly was due to the splicing coming loose, or it may have been due to some mechanical condition of the boot pulley or the head pulley; it might have been due to overloading with feed.

X-Q. 167. I see your last remark is "overloading feed to elevators, unable to handle return feed."

A. Well, it might have been due to that, if the

Ben H. Dosenbach.

elevator—They might have become overloaded, and conditions of flotation were very poor during that time.

X-Q. 168. And the correction of that would be to cut down the return feed?

A. Well, it would be to cut down the original feed, and therefore that would cut down the middling or return feed.

X-Q. 169. Well, you showed in your flow sheet yesterday a method of cutting down the middling return by putting a certain number of boxes out of operation, did you not?

A. That is one way of cutting it down all the time, but if it is running too high with those boxes cut out, then there would have to be some other method of reducing the overloaded condition.

X-Q. 170. Did you, during February, cut out some of the boxes in order to diminish the return feed?

A. No, I don't think so.

X-Q. 171. When did you commence to do that?

A. I think that was in March.

MR. WILLIAMS: Nothing further at present.

REDIRECT EXAMINATION.

BY MR. SCOTT:

R-Q. 172. Will you describe the model machine which you have had made, just generally, and you can go more into detail with these drawings, but just a general statement of what it is.

MR. SCOTT: I simply propose a general descrip-

tion from the witness with reference to the flow sheet, because it is so difficult to get it on the record when we are looking at the machine itself. When we get this general description in, then he can amplify it.

A. The model machine which I have had made is a flotation unit in itself, and consists of a rougher having seven cells and three additional agitators, which produce a rougher concentrate and a middling product, the same as is produced in actual flotation operations. This model unit also consists of a cleaner and a recleaner. The middling product from the rougher—the rejected product from the cleaner and recleaner are returned to the head end of the rougher cells by means of an elevator. This unit also consists of a feed tank, or what we commonly call a sludge tank, which supplies the feed to the first cell and also takes care of the return middlings, such as the middlings from the rougher and the tailing from the cleaner and recleaner. This machine shows in itself the working of a unit in flotation, therein all of the products are taken care of; the middlings are returned as is done in actual practice; the tailings are rejected and concentrates are produced on the cleaner cells.

R-Q. 173. I hand you this flow sheet which you have prepared and ask you to explain to the court the flow of the material, and you may at the same time, if you desire, refer to this sketch which you have had made.

MR. SCOTT: I offer the flow sheet.

The flow sheet marked DEFENDANT'S EXHIBIT No. 224.

Ben H. Dosenbach.

MR. SCOTT: I offer the perspective sketch of the machine.

Perspective sketch marked DEFENDANT'S EXHIBIT No. 225.

MR. WILLIAMS: We reserve our objection to these.

A. Referring to the flow sheet of the model flotation plant, Exhibit 224, I will now endeavor to show the flow of the material through this complete unit. To begin with, the ore and water are placed in the sludge tank, which is the feed tank for the original feed, and that tank discharges into the pulp elevator, which is this elevator here on 225, where it is elevated to the first agitating cell, which is Cell No. 1. The material then passes through these three cells in series and into the fourth cell, which has in direct connection a spitzkasten. Now, we have seven cells with spitzkasten, which we will call the rougher cells, these three previous agitating cells are emulsifiers; these seven cells are rougher cells, producing rougher concentrate and middlings. The first three cells produce a rougher concentrate, which is retreated in a cleaner cell down below, which is this cell on the perspective view.

R-Q. 174. State how the pulp goes from one cell to the other.

A. It flows from one cell to another by gravity; there being a difference in elevation between the first and second and second and third and so forth on down through and including the seven, so that the upper one

is higher than No. 2, and therefore the flow of the pulp is by gravity into the succeeding cells.

R-Q. 175. Where is the passage?

A. The passage is in the corner of the spitzkasten.

R-Q. 176. And runs to where?

A. Directly into the agitating cell of the succeeding cell.

R-Q. 177. Does this illustrate the movement of the pulp here?

A. It does; the movement of the pulp is from your first agitating cell, which is in direct connection with the spitzkasten, into that spitzkasten; from that spitzkasten into No. 2 agitating cell, and from that cell into the same spitzkasten, which is directly connected with it; and from No. 2 spitzkasten into No. 3 agitating cell, and so forth on down the line, until the final tailing is made by No. 7 spitzkasten. That would be from this agitating cell to this spitzkatsen, and from this spitzkasten into this second agitating cell, and into the second spitzkasten, and so forth on down the line.

Now, the concentrate that is produced in number one cleaner is retreated again and purified in the No. 2 cleaner, which produces a finished concentrate. The rejection or tailings from each of these cleaners, and from both of them, joins with the middlings that is produced by the last four rougher cells and goes back again into the elevator where it is elevated with the original feed to the first agitating cell. So, in this unit we have after starting and in constant operation, we have this

Ben H. Dosenbach.

battery of seven rougher cells treating the original ore plus the return middlings as shown, which is done in actual practice. The middlings are retreated in actual practice with the original ore.

THE COURT: Tailings only from the seventh?

A. Tailings only made from the seventh cell and the tailings from the cleaner and recleaner are returned again. They contain more mineral than the middlings that are produced by the last four cells of the rougher—that would be these last four cells as you look at the machine, facing you.

MR. SCOTT: Now, if the court will consent to go to the Grand Jury room we will be prepared to operate the machine, and in connection with the operation the stenographers inform me that it is almost impossible during the operation of the machine to make any record, so I would suggest that such explanation be made there as necessary to enable the court to understand the machine and then afterwards Mr. Dosenbach can take the stand when we return to the court room and put it in the record. I make this statement because the stenographers seem to despair of getting down all that is said while the machine is being operated and numerous questions are being asked. If that is agreeable to the other side I suggest we proceed that way.

MR. WILLIAMS: If it is agreeable to the court.

THE COURT: Yes.

MR. WILLIAMS: In view of the fact that you have a large machine that has a great many parts and at which things occur, I would like to send up a sufficient

number of representatives to be able to watch the operation. One man cannot watch that machine.

THE COURT: There is no objection.

THE WITNESS: You mistook my statement, because if I was to proceed ahead of you to get ready in the two minutes it would take to get up there, you might send one man along to see that I get up there safely.

2 p. m., May 5th, 1917.

R-Q. 178. Mr. Dosenbach, will you describe your procedure in operating the model plant which you operated this morning?

A. The operation of the model flotation plant in which the experiment was performed this morning was as follows: 146 pounds of water at a temperature of 16° C. was added to the sludge tank. The agitators and elevator and mechanism in the sludge tank was added to the water in the sludge tank. This formed a pulp of 146 pounds of water and 60 pounds of ore. Next, 65 c.c. of sulphuric acid was added, together with 78 c.c. of copper sulphate solution to this pulp in the sludge tank. The pulp was then circulated through the elevator and through the rougher cells until thorough mixture was obtained, and the oil was then added to the first agitating ore emulsifying cell. The total amount of oil added was 665 c.c. This oil is equal to 574.6 grams, or the total amount of oil used in the test was 1.268 lbs., which is equal to 2.11%, or 42 lbs. of oil per ton of ore. The copper sulphate solution used was the regular copper sulphate solution that is used at the

P. 3900, L. 19, insert "then started and 60 pounds of Butte & Superior ore were" before "added"

Ben H. Dosenbach.

Butte & Superior flotation plant, and was equal to 7.4054 lbs. per ton, or 0.1 pounds metallic copper per ton of ore. The sulphuric acid used was commercial sulphuric acid, 59° Be., and the quantity used as stated before, was 65 c.c., which was equal to approximately 8 lbs. of sulphuric acid per ton of ore. The oil was added to the pulp as it flowed through the cells; however, there was no tailing made during the time that the oil was run through the machine, in order that all of the oil should be thoroughly mixed up with all the feed as much as possible, so that when the feed became steady, it would have practically the same amount of oil in it as it continued to enter the machine. The gates were so regulated so that during the time the oil was being fed through the machine there was no concentrate or tailing made, consequently all of the pulp was circulated through the elevator and returned back through the machine again and to the sludge tank. After the oil had been entirely fed to the ore pulp, the machine was then regulated so that an overflow occurred on the first three spitzkasten and on the last four spitzkasten, and the tailing gate was opened and the tailings were then made and discharged regularly from the seventh cell of the rougher machines. A very copious mineral froth occurred on practically all of the cells at first. Later on the froth on the first three cells was much heavier than than the r foth on the last four cells, and on the seventh cell there was very little froth, as the mineral was being taken off on the first three cells.

Ben H. Dosenbach.

There was a gradual gradation of the amount of mineral contained in the froth from the first spitzkasten on down through the seventh spitzkasten, showing that in these later cells of the rougher series there was less mineral, consequently there was less froth. Samples were taken of the tailings and the concentrate, there being four special samples on the tailing and concentrate taken which represents fairly well the average of the machine. But the main purpose in demonstrating and showing the operation of this machine was to illustrate the flow of material through an operating unit which is very similar to that used at the Butte & Superior, in the matter of flow, and also to show the froth and character of froths that was formed in using oil equal to 42 pounds of oil to the ton. The operation of the cleaner and recleaner was somewhat erratic and consequently the froth and material in the cleaner and recleaner was not consistent and did not overflow continuously on account of the discharge gates and openings from these cells soaking up, causing the cells to drain very rapidly and also to fill up very quickly. The feed to the rougher cells was also somewhat erratic at times on account of the belt on the elevator slipping and giving quite a lot of trouble during the run.

R-Q. 179. What was the oil mixture that you used this morning?

A. The oil mixture used was 70% fuel oil, 18% pine oil and 12% kerosene and was the same oil mixture that is—that was used at the Butte & Superior plant on April 29th.

Ben H. Dosenbach.

R-Q. 180. That was the Sunday when the representatives of the plaintiff visited the mill?

A. On the Sunday when the representatives of the plaintiff visited the mill.

R-Q. 181. And what was the rate of flow of the pulp through the machine? I suppose you have stated in that terms of the solids, have you not?

A. Well, the rate of flow would average about a ton of ore every 24 hours—possibly more. That is just a guess on my part. I have made no tests to determine the capacity of the machine.

R-Q. 182. Well, what would you say that would amount to in a minute? Something over a pound a minute, wouldn't it be?

A. Yes.

R-Q. 183. And you had in it 60 pounds this morning?

A. Sixty pounds.

R-Q. 184. On that estimate it would take something like in the neighborhood of how long for the complete material to circulate through it once?

A. Well, it would be a pound a minute practically and therefore in an hour there would be sixty pounds circulate through it, but the sixty pounds was increased somewhat by the circulating load of middlings, which increased the total amount going through the machine.

R-Q. 185. This copper sulphate solution that was used, was that the same as was being used on Sunday, April 29th?

A. It was.

Ben H. Dosenbach.

R-Q. 186. And how does the proportion you used this morning compare with that which you used on April 29th?

A. Well, the proportions that I used this morning was in the same proportion of one as in all of the tests that have been run in the court's demonstration and it would be a fair average of what our operations consist of.

R-Q. 187. At the mill?

A. At the mill, that would be one-tenth of a pound of metallic copper per pound of ore.

MR. SCOTT: You may cross-examine.

RE-CROSS EXAMINATION.

BY MR. WILLIAMS:

RX-Q. 188. How about the speed determinations that you made?

A. I took the speed of the agitator shaft to be 1988 revolutions per minute or 1561 peripheral feet per minute.

RX-Q. 189. You had successive agitators rotating in different directions, didn't you?

A. Yes.

RX-Q. 190. What was the effect of the inclination of the blades? Was it in every instance to tend to force the liquid upward, having in mind the direction of rotation.

A. No, it was not. The machine at first was built to work with a rope drive running around each one of the agitator shafts as shown in the perspective

P. 3905, L. 22, cancel " in which to incline or present the pulp " and insert " incline as presented to the pulp "

Ben H. Dosenbach.

drawing, and that did not give us good satisfaction, so it was changed to individual drives for each one of the agitator shafts. Consequently, working with a rope drive such as is shown in that descriptive drawing, one shaft will revolve in one direction and the other shaft will revolve in the other direction, the one following the first one.

RX-Q. 191. Well, now, did you maintain the same direction of rotation that is shown in your drawing here, that is successive agitators revolving in opposite directions?

A. Well, I haven't given that any attention at all, I don't know whether it is myself. In fact I never paid any attention to it. These belts were all taken off and put on again several times. Of course they would have to be maintained because otherwise you would have your agitator blades revolving in the wrong direction.

RX-Q. 192. Well, what is the right direction for these agitator blades, as to the manner in which ~~they in which to incline or present the pulp~~?

A. With the face up.

RX-Q. 193. That is tending to force the liquid up?

A. Yes.

RX-Q. 194. And as the machine was originally designed and operated, as shown in your drawing, exhibit 225, were the successive agitators with reverse arrangements so that they would all tend to throw the liquid up?

A. All the agitators tended to throw the liquid up.

Ben H. Dosenbach.

RX-Q. 195. How long a time was consumed in the operation which you carried on this morning?

A. About an hour and ten minutes.

RX-Q. 196. And during that operation how many times was the pulp circulated through the machine?

A. Well, I couldn't say as to that. It would be something like—it would be in actual practice, and I can't say what that would be because some of the pulp in the flotation or in any milling operation, goes through an innumerable number of times, while others go through only for a short time. So I have no way of judging as to how long any part of it was in circulation.

RX-Q. 197. But in fact as you operated the machine at first, sending the rougher concentrates back and through the machine, these rougher concentrates must have gone through several times, must they not?

A. Oh, no doubt they did go through several times.

RX-Q. 198. That is to say they were taken off and sent back immediately as being less in bulk, then released ahead of the tailings that were sent back? Is that an expression of the situation?

A. No, the middling was not sent back. In fact there was no overflow on the first three cells while the entire feed was in circulation. It was only overflowed from—it was only the overflow from the last four cells which was returned and sent back through for circulation. There was no tailing made at that time, consequently all of the feed that came into the cells was sent back again.

Ben H. Dosenbach.

RX-Q. 199. And you maintained that condition of returning everything throughout the time that you were feeding the oil to the machine?

A. I did.

RX-Q. 200. And some time beyond that?

A. Until we could get conditions regulated, yes, sir.

RX-Q. 201. Were these conditions in that machine at any time regular conditions?

A. Yes, they were, for a short time. We had considerable trouble this morning, I will admit that, but that is a condition which might exist at any time; in fact it was very similar to the questions you asked me this morning what might happen to the elevator. It showed what might happen in an actual plant, what happened up there.

RX-Q. 202. These elevators were not overloaded, were they—or this elevator was not overloaded?

A. It might have been, and I might have started it.

RX-Q. 203. Do you maintain any definite time when that machine upstairs was operating in a normal manner?

A. Why, I think it was operating in a normal manner for a great part of the time, with the exception of the cleaner and recleaner. The rougher certainly was operating normally. The cleaner and recleaner choked up considerably, and it was necessary to clean them out, but the rougher cells operated normally for quite a period, and that was the main part of the run, I thought, was to illustrate the gradual gradations of the mineral froth on the various cells.

RX-Q. 204. Now, after you had got the oil in and were satisfied that you had reached proper conditions in the rougher cells, did you feed all of the overflow from the rougher cells down to the cleaner and recleaner, and did you continue that through the operation?

A. Yes.

RX-Q. 205. And the irregularity was in the cleaner and recleaner; they got choked up; that was why the feed was so irregular?

A. That was why the feed was so irregular.

RX-Q. 206. Of course the consequence of that was that the concentrate of the last machine, the recleaner, would accumulate for quite a time, and then come out in bunches; that was, I suppose, a description of what happened?

A. That condition existed at one time there that I know of, when I looked down that way and saw it; on account of the discharge gate or opening leading from the recleaner cells choking up.

RX-Q. 207. Of course in the regular operations the tailings go to waste, do they not?

A. They do.

RX-Q. 208. And you got to the condition nearest approaching regular operations when you were sending your tailings out into the tailings receptacle?

A. Yes.

RX-Q. 209. I noticed in the table that you put in this morning, defendant's exhibit No. 223, that I asked you for the percentage of oil in the tailings, which is

Ben H. Dosenbach.

the next to the last item; that for the 27th of February is wholly different from any other item; can you explain that?

A. Which one is that?

RX-Q. 210. You have, for instance, on the 28th 0.45; on the 27th 0.062; on the 28th 0.68. Now, that 0.062 seems to be very erratic. What do you think of that?

A. It is an error; it should be 0.62.

RX-Q. 211. I have made the correction in the original exhibit. Now, isn't it a fact that the column showing the amount of oil in the tailings shows that you are running to waste in the tailings more than twice as much oil as you used ~~to~~ before December 22nd?

A. It does; sure.

RE-DIRECT EXAMINATION.

BY MR. SCOTT:

R-Q. 212. Mr. Dosenbach, are there any more things which Mr. Williams inquired about that you have?

A. No, I think that is all, with the exception of some assays that are not completed, and the returns are not out.

MR. SCOTT: I offer in evidence the machine which Mr. Dosenbach operated this morning.

Machine admitted without objection marked DEFENDANT'S EXHIBIT No. 226.

MR. SCOTT: I offer in evidence the flow sheet marked 224, and the drawing, exhibit No. 225.

EXHIBITS 224 and 225 ADMITTED WITHOUT OBJECTION.

MR. WILLIAMS: I should say, in regard to the machine, on behalf of the plaintiff, that as an illustrative model of something in which the flotation process may be carried out, there is no objection to it. As a representation of what is practically our standard machinethere is no objection to it. But if the defendant is relying upon it as a representation of anything in the prior art, then we object to it as wholly irrelevant. With those qualifications it may be admitted.

THE COURT: Well, of course, it is like the other exhibits; it is in for all purposes that it ought to serve. and they may be pointed out in argument.

J. T. SHIMMIN recalled on behalf of defendant for further

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 1. You are Mr. J. T. Shimmin who testified before?

A. Yes.

Q. 2. You have a report, I believe, of the operations of the Butte & Superior flotation plant on Sunday, April 29th, from 1 to 5 p. m., during the interval

J. T. Shimmin.

when the representatives of the Minerals Separation Company were present?

A. Yes.

Q. 3. And this is the report?

A. That is the report, yes, sir.

Q. 4. Were these operations conducted under your charge?

A. Yes.

Q. 5. And those reports are the regular reports prepared in the ordinary course of the administration of the plant?

A. Well, they are more complete, but we keep practically the same record of all our operations.

Q. 6. To the best of your knowledge and belief this is a correct report of the operations referred to?

A. Yes, sir.

MR. SCOTT: I offer the report referred to by the witness in evidence.

Report admitted and marked DEFENDANT'S EXHIBIT 227.

MR. WILLIAMS: As far as I can see, your honor, this repeats the testimony of the witness as to things that occurred, but I have no objection to it provided we upon examination find that it is all right. It is a long document. It may facilitate matters to have it in the record.

J. T. Shimmin.

CROSS-EXAMINATION.

BY MR. WILLIAMS:

X-Q 7. Mr. Shimmin, is this a report for the whole day?

A. No, it is just the period from 1 to 5 p. m. of the 29th.

X-Q. 8. Where is your report of the whole day, the regular official report?

A. Well, that is not finished; I have got it in the rough, is all. I can furnish you with a copy of that, though.

X-Q. 9. I want to see the whole day's operations. As a matter of fact our representatives were there at half past ten, and from there on, although it is true the samples were not taken except during that period.

A. This covers the period that the samples were taken.

X-Q. 10. I want the record for the whole day's run, and the day before and the day after, and I would like you to bring me the original data that are on record in your office.

A. All right.

X-Q. 11. Now, these notes that have been put upon this—this first document here is a letter by you, and is your report to Mr. Bruce, the manager of that operation?

A. Yes, sir.

X-Q. 12. And to that you append these sheets?

A. And there is a letter from the chief chemist and the oil chemist.

J. T. Shimmin.

X-Q. 13. The chief chemist being R. B. Stringfield?

A. No; he is the oil chemist.

X-Q. 14. Who is the chief chemist?

A. Edward Walser.

X-Q. 15. And then there is this last letter to you; who is that signed by?

A. That is the head sampler?

X-Q. 16. And his name is—?

A. T. R. Featherly.

MR. WILLIAMS: It would seem that the regular procedure would be to call these men, but I am quite willing to take it prima facie in this form, and see if we can be satisfied with it.

THE COURT: Very well; they are available no doubt.

THE WITNESS: I have some figures that you asked for the other day, Mr. Williams, in regard to the assay of the sulphate.

X-Q. 17. The assay of the sulphate of copper that you purchased from the Anaconda Company?

A. No, just the amount of copper sulphate and sulphuric acid which we were using during the month of November, 1916. You also asked for the period of time that we used the reconstructed oil.

MR. SCOTT: I offer the memorandum produced by the witness entitled "Butte & Superior Mining Company, Data Compiled from Original Record, Flotation Plant Operations, Month of November, 1916."

Table admitted marked DEFENDANT'S EXHIBIT No. 228.

J. T. Shimmin.

X-Q. 18. Now, that other matter?

A. On November 17th reconstructed Barrett oil was used for 16 hours, and No. 2 pine oil for eight hours.

X-Q. 19. And each used alone?

A. Each used alone, yes.

X-Q. 20. In what proportion?

A. They were used separately. The reconstructed Barrett oil was used exclusively for a 16-hour period and the pine oil exclusively for eight hours.

X-Q. 21. In what proportion per ton of ore?

A. Well, those sheets that I gave you show that; I don't remember off-hand. On November 18th the reconstructed Barrett oil was used for 18 hours and No. 2 pine oil for 16 hours.

X-Q. 22. Have you described what reconstructed Barrett oil is, how it is made?

A. No, I have not. I don't know what this particular reconstructed Barrett oil was, but ordinarily we use about 95%.

X-Q. 23. How is it made; what does reconstructed mean?

A. Well, it is just simply distilled or cooked for a period of three or four hours with sulphur.

X-Q. 24. It is distilled under conditions so that the condensed part flows back?

A. Flows back, yes.

X-Q. 25. In a reflex condenser?

A. Yes.

X-Q. 26. That No. 2 pine oil, how is that differentiated from No. 1 pine oil?

Ben H. Dosenbach.

A. It is simply a marking that they have.

X-Q. 27. A commercial name?

A. A commercial name, yes.

X-Q. 28. Yaryan, is it?

A. Yes, I think it is; in fact I am sure it is.

WITNESS EXCUSED.

MR. SCOTT: I understand that samples have been furnished to plaintiff's representatives of all of the oils mentioned in these various reports, and that being the case I would like to have the record so show.

MR. WILLIAMS: Well, I don't know whether it is so or not. I can get reports.

MR. SCOTT: Very well, I will have Mr. Dosenbach testify to it.

MR. WILLIAMS: I think we got some nine samples yesterday, but I am not ready to say we have samples of everything. I will when I know it.

BEN H. DOSENBACH, recalled, testified as follows:

DIRECT EXAMINATION.

BY MR. SCOTT:

Q. 213. Will you please state what oil samples you furnished to a representative of the plaintiff and to what representative you furnished them?

A. I furnished a sample of number 1 creosote, number 2 creosote, Yaryan pine oil, Barrett's number 4, Graybull fuel oil, Jones' crude oil, Graybull paraffin

base oil kerosene and Yaryan mixed pine to representatives of the Minerals Separation Company, Mr. Higgins and Mr. Truran. These samples were requested of me to furnish.

Q. 214. They were samples of the actual materials used in the mill?

A. They were such as we use in the Butte & Superior Company's mill.

Q. 215. Were there any other samples of anything else furnished to them?

A. Yes, there have been samples furnished of every test that was made.

Q. 216. In court you mean?

A. In court.

Q. 217. Yes, but I mean the mill materials.

A. And samples were furnished Sunday of everything that was used, oils and acids and sulphates.

Q. 218. Sunday the 29th of April?

A. Yes, sir.

CROSS-EXAMINATION.

BY MR. WILLIAMS:

X-Q. 219. Mr. Dosenbach, it appears that these pine oils are used separately, and you have given us a mixed sample?

A. I gave you two samples. The oil is contained in one tank, which contains several pine oils and when we use from that tank up there consequently we can not use either one of them separately. We do not have the capacity to put one particular oil by itself so that one

Ben H. Dosenbach.

tank contains mixed pines; and a sample of this was furnished and also a sample of the standard pine was furnished.

X-Q. 220. And that standard pine, has it any particular name? Is it number 1?

A. No, we call it "standard pine oil" because it has the greater specific gravity, and is somewhat purer than the other.

X-Q. 221. Can you furnish a specimen of the number 2 separate, that you formerly mixed with the standard?

A. I think it may be possible from the stock bottles to furnish that.

X-Q. 222. Will you do so?

A. I will, yes, be glad to.

MR. KREMER: Mr. Williams, Mr. Chapman and Mr. Truran, whose names are mentioned, are your representatives, are they not?

MR. WILLIAMS: Oh, yes, yes.

WITNESS EXCUSED.

MR. SHERIDAN: If the court pleases, I have an understanding with counsel on the other side that we may introduce a printed transcript from the stenographer's record taken from the argument of both sides in the Supreme Court. We desire to enter a part of the argument which appears on page 85, Mr. Kenyon's admission. In reference to that he wants me to read into the record beginning on page 83 down to the bottom of page 85 and that I agreed to do. They will object to its competency.

MR. GARRISON: No, we do not obpect to its competency. We object to its relevancy and materiality. We do not require them to produce any proof that the language contained on the pages of this book which are referred to is the language used by Mr. Kenyon or the language used by Justice McReynolds or by Justice Pitney, or whoever uttered the language. We will waive the competency of proof. We do say it is utterly irrelevant and immaterial.

MR. SHERIDAN: We will read that so it will appear in the record and then offer the book as defendant's exhibit 228.

MR. GARRISON: By what procedure do they read it into the record before your honor has admitted it?

THE COURT: What are you offering?

MR. SHERIDAN: We offer the part on page 83, page 84, and page 85. The reason of the materiality of it is this: First, it goes to show the definition these gentlemen have placed on their invention; and, secondly, they are alleging in this case that we are estopped by the Hyde former adjudication. Certainly anything that makes then in favor of Hyde in the former adjudication would make in favor of the defendant here; and any admissions made in solemn court such as they are, are undoubtedly of advantage to the court in any case in which he is a party. We have set it up as a defense, estoppel.

THE COURT: Well, there ought to be some law about that. I will allow it to go into the record, however.

MR. GARRISON: Your honor does not care to hear me before the ruling?

THE COURT: Nò, it will be before—let's see, how many other courts? One court at least. The objection will be overruled and the matter will be admitted, the three pages, and if entitled to no consideration the court will give it none in making up its decision.

Pages in question admitted in evidence and marked DEFENDANT'S EXHIBIT 229.

MR. SHERIDAN: (Reading): "Washington, D. C., Tuesday, October 1, 1916.

"Argument of Mr. William Houston Kenyon in reply for Petitioners-Complainants.

"MR. KENYON: May it please the court, the question at issue, and the only question, is the question of invention. Did the step that our patentees took constitute invention? The court below said no; it was simply a matter of degree. Respondent's counsel here defends that proposition by saying that our result is attained not by the diminution in the amount of oil, but by some trick of agitation, some novelty of agitation. I will address myself first to that latter proposition.

"And the history of the birth of this invention is a complete answer to it. (Record pp. 446-448-451).

"If your honors have not already marked those pages in the record, I will ask you to mark them; the whole of page 448, the whole of page 451, and, on page 445, the paragraph just below the middle, commencing 'peripheral velocity of cone.'

"Contemporaneous documentary records, written within a few weeks of the birth of this invention—evidence of an extraordinary character of the birth of a most extraordinary invention. These inventors were working on the Cattermole process—which, as has been explained, agglutinates by oil in about three per cent proportion the metal particles into bigger granules such that they sink against an upcurrent of water which carries the gangue up and away—the Cattermole process. They were experimenting with modifications of all the conditions of that process. Among them one line of investigation was as to the influence of changes of peripheral velocity. All sorts of variations, from 840 to 1,460, in the speed of the cone, were made, but the invention in issue was not born.

"Another line of investigation was as to the influence of changes in the amount of oil (page 447, the seventh item). Out of that series of experiments (where the only change made from experiment to experiment was in the amount of oil—a gradual diminution in the amount of oil, all other things remaining the same) was born this invention.

"And the record of it is right there on page 448, 'Details of Experiments,' the last column, 'Remarks,' 'Float vastly increased'—tracing that back you see it was with three-tenths of one per cent of oil; and just below 'Float' again 'vastly increased'—tracing that back it was with one-tenth of one per cent of oil.

"This float phenomenon appeared (page 451) when the oil had been reduced to about one-half of one per

cent, said the inventors, after studying the process six weeks.

"As the amount of oil was reduced granulation practically ceased at a range of about one-half of one per cent of oil, but a certain amount of black mineral froth was noticed. They were trying to send the values down, but they began to come up to the top.

"MR. JUSTICE DAY: Is that on page 451?

"MR. KENYON: Page 451, the third paragraph:

" 'A certain amount of black mineral froth was, however, noticed as a result. On successively decreasing the amount of oleic acid below 0.5 per cent (that is one-half of one per cent) it was found that whereas granulation ceased there was a growth in the amount of mineral float-froth under these conditions, and that the production of such float-froth appeared to reach a maximum when about 0.1% of oleic acid on mineral was used.'

"If that evidence is true it disposes of the contention that this phenomenon which has revolutionized ore concentration the world over is to be explained as some trick of agitation.

"MR. JUSTICE DAY: How do we know that fact, that it has revolutionized ore concentration the world over?

"MR. KENYON: How do we know it? This record shows that up to 1912 about $9,000,000 worth of values had been taken out, in Australia and Sweden and Chile, from dump heaps that had been valueless theretofore, by this process. The testimony that was taken in 1915 before Judge Bradford shows what had

happened in the intervening three years, as pointed out in his opinion, during which three years an astounding development occurred in this country.

"MR. JUSTICE M'REYNOLDS: I would like to ask you when in this process of reducing oil your invention came into existence.

"MR. KENYON: At about one-half of one per cent of oil.

"MR. JUSTICE McREYNOLDS: Before you got to one-half of one per cent did you have any invention?

"MR. KENYON: We were passing from the region of Cattermole, which was a distinct—

"MR. JUSTICE McREYNOLDS: I want to know when your invention came into existence.

"MR. KENYON: This invention was not reached, I should say, from those figures, until about 0.5, that is, one-half of one per cent., of oil was reached.

"MR. JUSTICE McREYNOLDS: At one per cent you had no invention?

"MR. KENYON: No.

"MR. JUSTICE McREYNOLDS: At one-half of one per cent you did have invention?

"MR. KENYON: It began to come. Remote, but it began to come. At 0.3 of one per cent the float vastly increased. At 0.1 of one per cent ~~of oil~~ the float again vastly increased.

"MR. JUSTICE McREYNOLDS: When this float has more than one-half of one per cent of oil it does not infringe?

"MR. KENYON: It does not infringe.

Frank R. Wicks.

FRANK R. WICKS, recalled, testified as follows:

DIRECT EXAMINATION.

BY MR. KREMER:

Q. 1. I believe you have some tabulations and some information Mr. Williams requested?

A. Yes, sir.

MR. KREMER: Mr. Williams, these are matters that I think you have requested Mr. Wicks to produce, and he now produces them. So as to keep the numbers correctly we will offer them, a document "Chino Copper Company, Hurley plant, flotation data for period from November 1 to 30th, inclusive, 1916, retreatment of concentrates."

THE WITNESS: That is a copy of the original report.

Report admitted in evidence and marked DEFENDANT'S EXHIBIT 230.

MR. KREMER: We now offer the following paper, headed Chino Copper Company, Hurley plant, resin and reagents used in vanner concentrate plant, during November, 1916.

Report admitted in evidence and marked DEFENDANT'S EXHIBIT 231.

Q. 2. Mr. Wicks, I believe you stated that you came to Butte in the latter part of 1912?

Frank R. Wicks.

A. Came to Butte first the last week in October, remaining here for about two weeks and then I came back on the first of Deecmber to take charge of the plant.

Q. 3. Who was in charge of the Butte & Superior plant as superintendent at that time?

A. That is the time that I came here in 1912?

Q. 4. Yes.

A. Well, Mr. Atwater was general superintendent, having charge of both the mine and the mill; and Mr. Collins was superintendent of the mill before I took charge.

Q. 5. What if any, conversation did you have with Mr. Atwater at that time with reference to the employes of the company engaged in and about the operations?

MR. GARRISON: I object. Conversations between employes of the defendant company certainly can't bind the plaintiff in this case.

MR. KREMER: This is for the purpose of impeaching the testimony of Mr. Atwater, who stated that Mr. Hyde was an employe. Mr. Atwater stated in his testimony that Mr. Hyde drew a salary from the Butte & Superior Company and that he had the right to discharge him. This is for the purpose of impeachment of the testimony of Mr. Atwater, to show a contrary statement by (him to) the witness.

THE COURT: Well, did you ask him, Mr. Atwater?

MR. KREMER: Yes, I asked him what if any conversation he had had with Mr. Atwater.

Frank R. Wicks.

MR. GARRISON: He means did you ask Mr. Atwater for the purpose of laying a basis for the contradiction.

MR. KREMER: I don't think we have to lay a basis for impeachment of that kind when the witness' statement is absolutely contrary to the statement he has made in the course of his employment.

THE COURT: I think so. I know of no exception. If you are going to impeach him by showing contrary statements by him, certainly the foundation must be laid. You can show the fact to be otherwise, that Mr. Atwater had no such authority.

MR. KREMER: I can show that in another way. When Mr. Atwater was off the stand and they closed their case before this information came to us.

THE COURT: I know, but that is your misfortune, but it does not do away with the law governing such testimony.

MR. KREMER: The obstacle is not *Ossa Pelion*, by any means, because I can find another way.

Q. 6. Who was in the employ of the Butte & Superior Company at the time you came there in the latter part of 1912, in the matter of conducting of flotation operations?

MR. GARRISON: I object. I can't see how it is relevant as to who was in the employ of the Butte & Superior Company at that time.

MR. KREMER: Positive testimony that a certain man was in the employ of the company. We have a right to meet that, not by the statement of anyone, but by the fact.

Frank R. Wicks.

THE COURT: What was this witness' relation?

MR. KREMER: He was mill superintendent; came there to take charge of the mill and did operate the mill.

THE COURT: I will be frank with you and say it is so long since Mr. Atwater testified that it has passed my recollection somewhat except in its more vital portions. Certainly if Mr. Atwater testified that a certain person was in the employ of the company, and if that was material, why, certainly, the defense has a right to disprove it.

MR. KREMER: The only attempt they have made to prove their allegation that he was an employe of the company. They have alleged that he was an employe of the company. That is the only attempt they have ever made to prove that statement.

THE COURT: Well, get a little more directly at it, with this witness. Ask him whether he knows the relation.

Q. 7. MR. KREMER: Was Mr. Hyde in the employ of the Butte & Superior Company at the time you came there?

MR. GARRISON: Now, if your honor please, that must be a matter of law.

THE COURT: Ask him what he knows about the relations between Mr. Hyde and the defendant, what he knows of his own knowledge.

MR. KREMER: Very glad to ask it in any way court or counsel direct. In fact, it is only the ultimate conclusion we are desirous of reaching.

Frank R. Wicks.

Q. 8. What do you know of the relations between Mr. Hyde and the company, if there was any, in October, 1912, and the latter part of 1912, when you came to the plant?

A. All the information I have is what Mr. Atwater told me when I took the place.

Q. 9. Who was Mr. Atwater?

A. He was general superintendent of the plant.

Q. 10. What did Mr. Atwater tell you?

MR. GARRISON: Now, I object to what Mr. Atwater told him.

THE COURT: Objection sustained.

MR. KREMER: Exception. Now, if your honor pleases, I desire to make an offer to prove. I suppose I may just as well state it?

THE COURT: Certainly.

MR. KREMER: We desire to prove by the witness, F. R. Wicks, now upon the stand, that the witness M. W. Atwater, who has previously testified in this case, stated to Mr. Wicks when Mr. Wicks came to the plant that Mr. Hyde was not an employe of the Butte & Superior Copper Company, Limited. We desire to prove by the witness upon the stand and offer to prove by the witness upon the stand that the witness asked Mr. Atwater who Mr. Hyde was and that Mr. Atwater replied that Mr. Hyde was the originator of the Hyde flotation process which was then being used in a general way, that he told—that Atwater told the said witness, Wicks, that Hyde had undertaken to direct the installation of a flotation equipment, and

the development of a successful plant, but that he was having plenty of trouble doing it. We desire further to show by the witness, Wicks, upon the stand, that the said witness asked the said Atwater if Hyde was retained as consulting engineer or whether he was in the employ of the company, and that the said Atwater told the said witness, Wicks, now upon the stand, that Hyde was neither an employe nor a consulting engineer, but that he had contracted to do certain things, and that up to that time hadn't succeeded in doing them. We desire to further prove by the witness upon the stand that the said Atwater explained to the said witness, Wicks, now upon the stand, the contract between Hyde and the company and showed him a copy of the contract and allowed the witness to read it over so that he would be familiar with the situation. We desire further to show by the witness upon the stand that he came to Butte to rearrange the milling forces and to assume the position of mill superintendent. We desire further to show by the witness upon the stand that he became mill superintendent and that the said Hyde was not an employe of the said company, but was operating as an independent engineering contractor.

That covers the offer, and in making the offer I desire to state that we will prove any one or all of the statements there contained.

MR. GARRISON: I do not care to be met with an offer. I prefer to have him ask the witness questions.

Frank R. Wicks.

MR. KREMER: We have a right to make an offer after the court has ruled.

THE COURT: He asked a question which was objected to and the court sustained it. Now, he simply makes an offer of what he would prove.

MR. GARRISON: I am faced now with the necessity of objecting to this offer, in which case, if your honor pleases—

THE COURT: This offer is only a continuation of the former question. It is only the same matter, just what Mr. Wicks says.

MR. KREMER: The offer is in compliance with the ruling of the court. I cannot continue to ask questions.

THE COURT: State your objection.

MR. KREMER: You may interpose your objection.

MR. GARRISON: Thank you, sir.

MR. KREMER: You are entirely welcome.

THE COURT: Proceed.

MR. GARRISON: I do not care unless your honor rules that that is the practice in this district.

THE COURT: It is the practice here.

MR. GARRISON: I am then put at the peril of admitting that he can prove all of this and objecting that it is immaterial. I do not care to be fronted with that. I would prefer infinitely to have him ask the questions. I don't think this witness can testify—

MR. KREMER: Do you withdraw your objection to the previous question.

Frank R. Wicks.

THE COURT: No. I remember a case once before a jury and counsel asked a question and it was objected to and sustained. The jury was sent out and he made a very long and very striking offer, and the court permitted him to call his witness and see if he could testify to that. He immediately withdrew his offer. Now, there is no charge in that—

MR. KREMER: If that is a challenge, I accept it.

THE COURT: That is what counsel is guarding against. He don't want to admit that all of these things would be testified to because sometimes strategy and enthusiasm will lead a counsel to offer a lot more than he can carry out. Now, he has a right to take that view, for his protection.

MR. KREMER: I am willing he may object to any part of the offer.

THE COURT: He only asks a division, so that you only ask one question at a time,—well, as a matter of fact, when you don't have a jury in court it won't matter. It will really go into the record.

MR. GARRISON: I shall have to object to some of these questions. I think I would like to have this gentleman's views on certain questions.

THE COURT: Ask questions.

Q. 11. MR. KREMER: Did you have a conversation with Mr. Atwater with reference to Mr. Hyde's connection with the Butte & Superior Copper Company, Limited, when he came to Butte to take charge of the milling operations.

A. Shortly after I came there; yes, sir.

Q. 12. State the circumstances of that conversation?

MR. KREMER: Now, I want to be very fair with him and I won't ask questions that will lead him.

MR. GARRISON: I do not think that that can show the relation between Mr. Hyde and the Butte & Superior Company. We already have in evidence a written contract which counsel says was shown this gentleman, and says Mr. Atwater gave him a copy of that contract. I don't know whether that would be relevant or not. He may have put a construction of his own on that contract. I doubt very much whether that would be relevant. We have the original showing exactly what the money was paid for, in his vouchers, and we have them here and it seems to me it resolves itself into a question of law and Mr. Atwater, I have found from reading the testimony—testimony in this respect, reading from page 139 of the transcript: "Q. 13. During the time that you were superintendent, from the date that you mention in 1911 down to the time that you ceased your connection with the company in February of 1913, did you at any time pay moneys to James M. Hyde on behalf of the Butte & Superior Compand, the defendant? A. Yes. Q. 14. Did you pay him a flat sum of money per day or did you pay him moneys made up of items of expenses or both? A. We paid him so much a month." Now then, the

vouchers show payments monthly, payments with all the descriptive language that the vouchers of these companies have upon them to show for what the payment was made and the contractual relations, about which this gentleman I do not understand has any original information. If he has, that is another matter. If he is here to testify to any phase of the making of the contract between Hyde and the Butte & Superior, I shall withdraw my objection instantly; but as I understand it he came there long after this contract had been made; and there is no offer to prove that he had anything to do with that. Then his construction of the contract must be immaterial. What characterization he would put upon these payments certainly would be immaterial.

THE COURT: Are you shifting your ground from the objection formerly made which was that this can only serve to impeach Hyde and no foundation has been laid?

MR. GARRISON: You mean Atwater?

THE COURT: Yes. Are you abandoning that?

MR. GARRISON: No, sir, I am not. I am reinforcing that ground because he is now asking what talks he had with Atwater about Hyde. I cannot see that that is material.

THE COURT: You desire counsel to put it in the form of a question?

MR. GARRISON: I do.

THE COURT: So state. If you have any objec-

Frank R. Wicks.

tion to this question state it so the court can tell and we can go on to the next one.

MR. GARRISON: My objection is that conversations between Mr. Wicks, this witness, and Mr. Atwater inquired about by counsel in this case, are irrelevant and immaterial; and, if intended to impeach Mr. Atwater, no proper foundation is laid for them.

THE COURT: The objection will be sustained.

MR. KREMER: I now renew my offer. I am perfectly willing to rest upon my offer. I made no request that I be permitted to ask any further questions. I abide by the ruling of the court and I now renew my offer to prove by this witness as previously stated.

THE COURT: Let's see your offer.

MR. KREMER: I haven't it reduced to writing, but I will show you from what I read. This is the substance of it.

THE COURT: This offer is in reference to what Mr. Atwater may have stated to this witness.

MR. KREMER: No, I want to show as I stated before, we desire to show the relationship existing. First of all, I stated it was for the purpose of impeaching the testimony of Mr. Atwater. My first question was—I desire to show by this witness first that Mr. Atwater's statement is to be discredited because of a statement of a different character made to the witness. That is one reason. Second, I desire

to show by the witness the connection of Mr. Hyde with the company as outlined by the general superintendent of the company, Mr. M. W. Atwater, who has previously testified in this case, and to show that notwithstanding the fact that Mr. Atwater as previously upon the stand stated and at a time when we did not have this information available or know of it, has stated that he paid Mr. Hyde a salary and that he had the right to discharge him. And for that reason we consider this testimony competent and most material.

MR. GARRISON: I would like to have counsel point out that portion of Mr. Atwater's testimony that he proposes to show this statement of conflict.

MR. KREMER: I don't know the page of it.

MR. GARRISON: Then point out one place.

MR. KREMER: All right, I will. I will show you the word "salary."

MR. GARRISON: All right, do so.

Q. 15. First of all, I will supplement this; page 138. "Did you pay him any money? A. We paid him so much a month." I will show you the word salary.

MR. GARRISON: I remember the word salary, and I remember that he took it back later. He took back a lot of things.

MR. KREMER: We have a right to impeach anything that he said on direct, notwithstanding his equivocations on cross examination.

THE COURT: Under no rule by which Mr. Atwater's statement to this witness could be admitted

Frank R. Wicks.

here to serve the defendant except under the rule of impeaching testimony. If there is any such rule I am either ignorant or forgetful of it at this time. No foundation having been laid by the method always understood—"Did you say thus and so to so and so in the presence of such parties at such a time and place?" It is inadmissible.

MR. KREMER: Your honor realizes the situation.

THE COURT: Yes, but I have had that question up before, and it has gone to the Circuit Court of Appeals of this circuit in the case of Egan vs. Great Northern, and it was ruled out there and the court sustained me.

MR. KREMER: That is the statement of a witness (I think I can see a difference here), for the purpose of impeaching his credibility. This is testimony with reference to a statement of fact. Here is a man who was general superintendent of the company, charged with knowledge, and of knowing who were his employes. His statement is a statement of fact; and if a condition is altered, whereby a former general superintendent seeks to take the stand to testify against his former employers with reference to something that was presumably within his knowledge and based on what occurred under his superintendency, then it becomes fact testimony as to what he said with reference to the condition of affairs when he was superintendent. Your honor must bear this in mind—I appreciate that it is a nov-

elty, but Mr. Atwater's sole information given here on the stand was of a character relating to his superintendency; and certainly, if that is testimony—A statement made by him at that time in connection with the same matter is a statement of facts, rather than a mere question of direction to his credibility. The situation is a trifle unusual, but I see no way of raising this question under the objection of the parties and the objection being sustained by the court, than by an offer of proof, which I have made in accordance with the practice. I have not attempted to impeach anything in that offer, save and except that which I propose to prove and which I have here offered, the data from which I made the offer of proof.

MR. GARRISON: Do I understand that under the practice I have got to accept or reject that offer?

MR. KREMER: No, I think not, Judge Garrison; if you will wait a moment—

MR. GARRISON: I beg your pardon; I will sit down.

MR. KREMER: I wish you would, occasionally; the statement whether he is to accept or reject is as to the competency of that testimony. If that testimony is competent, and if he has relied upon his knowledge of the rules of evidence in directing the objection to the court, and the court is in accord with his view, and he desires that objection to remain, then certainly he is charged with the truth of that

Frank R. Wicks.

testimony, or at least he is charged with the knowledge that the witness would testify to it.

THE COURT: The error, if error is committed—I don't understand that the Circuit Court of Appeals will take it as the same as though that testimony were in the record. If it is sufficiently material they will send the case back to give an oppontunity to have it introduced. But I remember another case where the court sustained an objection—perhaps you have heard of it—The witness was asked to relate a certain occurrence in a conversation, and the witness was asked "What did Mary say?" and it was objected to and the objection sustained, and it went to the Court of Appeals, and they held that it was error and sent the case back, and when it came back they asked the witness again, "What did Mary say?" and the witness answered "Mary did not say anything." So that involved the Circuit Court of Appeals for that trifling matter. (Laughter.) Now, it is something the same here. If I exclude this and it goes to the Circuit Court of Appeals, the Circuit Court of Appeals will never say that the defendant has admitted that that is true; they will send it back to find out whether Mr. Atwater did say anything to the witness or not.

MR. KREMER: The situation is different; we have already told you what "Mary" is going to say.

THE COURT: Yes, but the witness has not testified to it. It does not involve the construction the plaintiff places on it. The court could inquire, as a

matter of good faith, like it did inquire as it has told you about, and I think the offer is properly made, and you can state your objection to it as it is.

MR. GARRISON: I am not going to object to the offer, your honor.

THE COURT: Proceed, then.

Q. 16. What did Mr. Atwater say with reference to Mr. Hyde?

MR. GARRISON: Now, I object to the question, if your honor please.

THE COURT: I see the method counsel is taking, and I can not say that he is not correct. He simply intends now that you should put your questions as you desire, and he will object to each specific question as it comes, if he wants to. The objection will be sustained to this question.

Defendant excepted.

MR. KREMER: Now, if your honor please, I renew my offer to prove.

THE COURT: The court will not entertain the offer to prove. You can put specific questions to this witness, which will cover your offer to prove. You can have an exception to the court's ruling on that?

MR. KREMER: I don't desire an exception; I only want an understanding. I would like to save time, if possible.

THE COURT: The court will finally say how its time should be taken up, and it says it will give you the time.

Frank R. Wicks.

MR. KREMER: All right, your honor, I will proceed on that line.

Q. 17. When you came to Butte, in the latter part of 1912, what conversation, if any, did you have with Mr. M. W. Atwater with reference to the employes —with reference to who were the employes in the Black Rock mill?

MR. GARRISON: That is objected to as incompetent, irrelevant and immaterial.

Objection sustained; defendant excepted.

MR. GARRISON: If it is intended to contradict Mr. Atwater there is no basis—

MR. KREMER: The court has ruled.

THE COURT: There is time enough for one at a time. I did rule, however, before you finished your objection, however, Mr. Garrison.

MR. GARRISON: I wanted to say that if it is intended to contradict Mr. Atwater, no proper basis has been laid.

Objection sustained; defendant excepted.

Q 18. What conversation did you have with Mr. Atwater with reference to Mr. Hyde's connection with the Butte & Superior Copper Company Limited?

MR. GARRISON: I object to that, if your honor please, if it is intended to contradict Mr. Atwater, on the ground that no proper basis has been laid; and otherwise I cannot see how it is relevant or material to any issue in this suit.

Objection sustained; defendant excepted.

Frank R. Wicks.

Q. 19. What did Mr. Atwater say to you with reference to whether Mr. Hyde was an employe of the Butte & Superior Mining Company, Limited?

MR. GARRISON: I repeat the objection that I just previously made.

Objection sustained; defendant excepted.

Q. 20. What, if anything did Mr. Atwater state to you with reference to an inquiry propounded by you, as to whether Mr. Hyde was a consulting engineer or whether he was in the employ of the company?

MR. KREMER: At this time I desire to state that if that is objected to on the ground that it is leading I will reform the question.

MR. GARRISON: I don't object to it on the ground that it is leading; I repeat the objection I made to the previous question.

Objection sustained; defendant excepted.

Q. 21. What if anything did Mr. Atwater say to you with reference to Mr. Hyde's contract with the Butte & Superior Copper Company, Limited?

A. Mr. Atwater told me that that contract constituted the only connection between Hyde and the company.

Q. 22. Did he show you a copy of the contract?

A. He did.

Q. 23. Mr. Wicks, I present to you Plaintiff's Exhibit No. 1 and ask you to glance over that and state whether or not the contract there set forth is a copy of the contract which you refer to.

Frank R. Wicks.

A. I can not identify it exactly from this copy, because I can not identify the signatures.

Q. 24. Would you just glance over it and see the substance of it, and if necessary, read it.

MR. GARRISON: This is the only written contract there was, isn't it?

MR. KREMER: There was a modification of this contract. I don't think the witness ever saw the modification.

A. I can identify it by one portion of it in a moment, when I find it.

MR. GARRISON: Outside of the record I will agree that it is the same contract so the witness may be at liberty to answer yes if he likes.

MR. KREMER: Very well, it is the same contract.

MR. GARRISON: I won't cross examine him about that.

Q. 25. It is, the contract, isn't it?

A. All right, with that understanding I can identify it.

Q. 26. When did you assume charge of the mill?

A. On the first of December, 1912.

Q. 27. Did you have control of all the men operating in that mill?

A. Yes, sir.

Q. 28. All of the employes of the company?

A. All of the employes of the company who were connected in any way with the milling operations or

Frank R. Wicks.

with the surface operations which pertained to the milling department.

Q. 29. Did you, Mr. Wicks, know James M. Hyde during that time?

A. Yes, I met Mr. Hyde then.

Q. 30. Was Mr. Hyde employed at that mill?

MR. GARRISON: I object to that.

THE COURT: The witness has already testified that he knew nothing of the relations of Mr. Hyde other than what Mr. Atwater told him, and this question calls for a conclusion; he can only make his answer from that information.

MR. KREMER: No, your honor, I believe the witness testified as to what Mr. Atwater testified as to the contract, and Mr. Atwater told him that that was the only connection with the company. This witness then took charge of the mill himself, and had superintendence over the mill and all the employes of the mill.

THE COURT: You can ask him what control he exercised over Mr. Hyde. This question calls for a conclusion and the objection will be sustained.

Defendant excepted.

Q. 31. What relationship—or at least what control did you, as mill superintendent, have over Mr. James M. Hyde. if any?

A. I had none whatever.

Q. 32. Was Mr. Hyde in and about the mill?

A. He visited the mill several times, yes.

Frank R. Wicks.

Q. 33. Any particular portion of the mill?

A. Particularly the flotation plant. I showed him through the other part of the plant, but he was around the flotation plant himself.

Q. 34. What would he do about the flotation plant?

A. Stand around and look at it.

Q. 35. Anything else?

A. I never saw him do anything else.

Q. 36. As mill superintendent it was your duty, I suppose to O K or approve the pay rolls of the company with reference to the compensation paid the men who worked in the mill?

A. Yes, I approved the mill payrolls, I think, every month, and during a part of the time I also approved the entire plant payroll.

Q. 37. Did the name of James M. Hyde appear on that pay roll at any time?

A. No; I can remember very distinctly that I never saw his name upon the pay roll.

CROSS EXAMINATION,

BY MR. GARRISON:

XQ. 38. How long did you remain the mill superintendent?

A. Until April, 1915.

XQ. 39. From what month in 1912?

A. From December, 1912, until April, 1915.

XQ. 40. And how long after you went there did Hyde remain there?

Frank R. Wicks.

A. I don't remember having seen him around the plant after February of 1913.

Q. 41. And when you did see him around the plant, what part of the plant was he around?

A. He generally went direct to the flotation plant.

Q. 42. And where was that with respect to the mill?

A. At the lower end of the mill.

Q. 43. And in the mill in the same building.

A. In the lower end of the main building.

Q. 44. And that flotation plant was entirely under the charge of Mr. Hyde, was it?

A. No, sir.

Q. 45. Under whose charge was it?

A. It was under Mr. Shimmin's.

Q. 46. And he was what sort of an official?

A. He was assistant mill superintendent.

Q. 47. You know that Hyde, of course, was paid moneys by the Butte & Superior Company for whatever he was doing, did you not?

A. No, I had no knowledge of what payment they were making on the contract.

MR. GARRISON: I move to strike out the part of the answer that is not responsive, the latter part.

MR. KREMER: We resist the motion, for the reason that the record shows that that was the only contract between him and the company.

MR. GARRISON: It is not responsive; I asked him if he knew they were paying Hyde money for whatever he was doing.

Frank R. Wicks.

THE COURT: It may be stricken after the word "no."

Defendant excepted.

Q. 48. Did you know what Hyde was doing there? Answer yes or no.

A. Yes, I knew.

Q. 49. And whatever he was doing, he was doing under Mr. Shimmin's direction, was he?

A. No, he was never under Mr. Shimmin's direction.

MR. KREMER: Mr. Shimmin came a year later.

Q. 50. I thought you answered a few minutes ago by saying that Mr. Shimmin was in charge of the flotation plant at that time.

A. Mr. Shimmin was—I was in charge of the entire plant, and Mr. Shimmin was directly under me in the direction of the operations; Mr. Kremer is wrong there. He succeeded me as superintendent.

Q. 51. I thought you told me a few questions back that he was under Mr. Shimmin's directions.

A. No, sir; I did not intend to tell you that.

Q. 52. Under whose direction was he?

A. I don't know.

Q. 53. You know, do you not, that Mr. Hyde did not have the direction of that flotation plant at that time, don't you?

A. Yes, I know that he did not have direct charge of the operation.

Q. 54. Who did have direct charge of the operation?

Frank R. Wicks.

A. Mr. Shimmin.

Q. 55. Whatever he did, he did under Mr. Shimmin's direction, did he?

A. I never saw Mr. Hyde do anything there.

Q. 56. Why do you say that his presence was detrimental; do you mean the mere bulk he took up?

A. Because of his advice and conversation with the employes.

Q. 57. Being useless?

A. Absolutely.

Q. 58. So that, as a matter of fact, whatever was done in that flotation plant after you got there, was done by Shimmin?

A. Well, it was done by me; I was in charge of the plant.

Q. 59. Yes?

A. But the major part of the direct operation was by Mr. Shimmin.

Q. 60. And that plant worked on Butte & Superior ore?

A. Yes.

Q. 61. And it was worked by Butte & Superior men?

A. Yes.

Q. 62. And whatever avails came from it went into the same coffers as all the other moneys of the Butte & Superior?

A. I don't know where the money went.

Q. 63. You have no reason to believe that it went to any other place, have you?

MR. KREMER: I object to that question as not proper cross examination.

Objection sustained. Plaintiff excepted.

WITNESS EXCUSED.

JAMES MACDONALD HYDE, a witness for the defendant, after being duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. KREMER:

Q. 1. State your name.

A. James Macdonald Hyde.

Q. 2. You are the same James M. Hyde who was defendant in the case of Minerals Separation Limited and another in a case brought in this court?

A. I am.

Q. 3. And prosecuted through to the Circuit Court of Appeals and to the Supreme Court of the United States?

A. I am.

Q. 4. Mr. Hyde, when did you come to Butte the first time?

A. I came to Butte in the spring of 1911; I believe it was in the month of March.

Q. 5. What was the occasion of your visit to Butte?

A. I came as an assistant examining engineer to

James Macdonald Hyde.

Mr. Kuehn, to make an examination of the Butte & Superior mine, I believe for Hayden, Stone & Company, of New York.

Q. 6. Did you at that time make any examination or make any tests as to whether or not the ores of the Butte & Superior Copper Company, Limited were adaptable to the oil flotation method of treatment?

A. I did.

Q. 7. By whom—For whom did you make the tests?

A. I made the tests directly for Mr. Herbert C. Hoover, who has since been chairman of the Belgian Relief Committee, and is so well known in that connection.

Q. 8. What was Mr. Hoover then?

A. He was a mining engineer and an independent operator, and in this particular business he was associated with Mr. Chester Beatty of New York, relative to in interest which Mr. Beatty and Mr. Hoover might have in a certain bond issue which was to be made. The object of my visit was nominally that of assistant examiner of mines with Mr. Kuehn. I took that position and acted in that capacity to familiarize myself with the situation so that I could determine for Mr. Hoover when the examination of the mine was over, whether or not the ores of the Butte & Superior Company could be so successfully worked as to make the bond issue probably a profitable venture.

Q. 9. Was Mr. Hoover connected with the Butte & Superior Copper Company, Limited?

James Macdonald Hyde.

A. Not to my knowledge.

Q. 10. Or any of the gentlemen mentioned by you, were they connected with the Butte & Superior Copper Company, Limited?

A. Not to my knowledge.

Q. 11. After you had made those tests, did you make a report to Mr. Hoover, Mr. Beatty and others?

A. I reported to no one but Mr. Hoover, until after Mr. Hoover had given me his permission to report to others.

Q. 12. When was that permission given, approximately?

A. My memory of the circumstances is this, that when Mr. Kuehn made his report in New York I received a telegraphic inquiry to know what results I had obtained in testing the ore by other methods than those used in the mill, and I replied that I could not inform anyone but Mr. Hoover, and that his permission would have to be obtained before I would make any report at all, and my memory is that I telegraphed Mr. Hoover asking that he give me permission—and that he gave me permission to inform Mr. Kuehn, not in definite figures, but in generalizations as to what I had learned.

Q. 12-A. Did you say anything to Mr. Kuehn?

A. I did.

Q. 12-B. Was Mr. Kuehn connected with the Butte & Superior Copper Company, Limited, if you know?

A. I don't think that he had any official connec-

tion with the company; my understanding was that Mr. Beatty was acting as a consulting engineer with Hayden, Stone & Company, as well as an associate in some business matters, and that this examination was being made for Mr. Beatty, or at the request of Hayden, Stone & Company through Mr. Beatty.

Q. 13. At that time did Hayden, Stone and Company have anything to do with the Butte & Superior direct?

A. I had no definite knowledge that they had, and understood that they had not.

Q. 14. When did you have a conversation or correspondence or communication with anyone connected with the Butte & Superior Company, Limited, upon the subject of flotation?

A. When the mine examination which I referred to was completed, I took a room at the Napton House in this town, for the purpose of having a kitchenette which would answer for a laboratory, and I tested the Butte & Superior ore there at my own expense, and bearing all of my own expenses, while my tests, were going on. I had a test machine made and tested the ore and while in the course of making my tests Mr. R. M. Atwater, arrived from New York and told me that he had there met Mr. Hoover and that Mr. Hoover had told him that I was acquainted with ore dressing in its many variations, and that he had requested me to investigate this ore and find what could be done with it, and Mr. Atwater—

James Macdonald Hyde.

Q. 15. State who Mr. Atwater was.

A. Mr. R. M. Atwater, I was informed, was the general manager of the Butte & Superior Company.

Q. 16. Proceed.

A. Mr. Atwater asked me to report to him as to the investigation that I was making and I told him that I could give no information to anybody but Mr Hoover.

Q. 17. And did you secure permission later?

A. I did not; I gave no information to Mr. Atwater at that time.

Q. 18. Well, what happened then, so that we will move along to the time when you did communicate with Mr. Atwater?

A. Mr. Atwater told me that he was going to New York, and the next that I heard was Mr. Maxwell Atwater reported to me that there had been a negotiation between Capt. Wolvin and Mr. Atwater and certain officials of the Minerals Separation Company, and that they had found, as he put it, that they would have to deed their mine to the Minerals Separation Company if they did any business with it, and he wanted to know if I could report to him at that time as to what could be done.

Q. 19. Who was this conversation with—M. W. Atwater?

A. With M. W. Atwater.

Q. 20. The same man who testified here?

A. The same man who testified here the other

day. At that time they asked me if I would make an investigation of the subject for them. I told them I knew nothing in regard to the progress of Mr. Hoover's negotiations and would take no action in the matter whatsoever. At a later date, upon further urging on their part that something be done in the matter, I cabled Mr. Hoover—my memory is that he had gone to London—and received word from him that his relations with the matter had ceased, and that I could do anything I pleased in the matter. I had been in Butte then a considerable length of time, expecting that something would be done in that matter,—One thing I forgot to state that would show my relationship to this—When I began this investigation at Mr. Hoover's request, it was with the understanding that if he and Mr. Beatty participated in the bond issue, they would carry me for a part of the bonds, and that—by that expression I mean that they would give me an option on part of the bonds at a price, and they would hold them for me from that date at that price, so that at some later date if the bonds increased in value, I would get a profit.

Q. 21. Was that the incentive that you had in making these tests?

A. Entirely so; at the time I had no other reason for working the ore myself.

Q. 22. Now proceed.

A. After Mr. Hoover's connection had ceased, and he had so informed me, and that I could do anything

James Macdonald Hyde.

that I pleased, and further urging upon the part of Mr. Atwater that I investigate and report to them upon the matter, I told Mr. Maxwell Atwater that I would do so upon one condition and one only, and that condition was that they should pay the expenses, and nothing more, of an investigation which would result in a study of the problem, and a determination of what could probably be done, and when I turned in that report to them they were to make me a proposition if they wanted the work done.

Q. 23. At that time was there any milling operation conducted in the United States by the use of the flotation process?

A. Not to my knowledge.

Q. 24. Did you have a general knowledge of mill operations?

A. I did. In the course of my investigations I had arrived at a practice which seemed to me different from anything that had previously been used, and I told Mr. Atwater of that fact. When I made my investigation it was on the understanding that when my report was rendered to them they should make me a proposition as to what basis they wished this work done upon, and that I would either accept or reject that proposition without debate. It was upon that basis that the investigation was made.

Q. 25. After the investigation was made by you, what if any contract did you make with the Butte & Superior Copper Company, Limited, then?

James Macdonald Hyde.

A. I entered into the contract which has been entered as an exhibit in this case.

Q. 26. You refer to plaintiff's exhibit No. 1?

A. It is so designated here.

Q. 27. Did you, at any time, have any other agreement with the Butte & Superior Copper Company save this agreement and the modification thereof, which I believe is also in evidence, verbally or in writing, having to do with your compensation for the conducting of these flotation operations referred to?

A. There was a preliminary agreement which does ont appear here; I don't know that it was anywhere in writing—that during this period of investigation I was to receive absolute expenses.

Q. 28. I think that is embodied in the contract also?

A. Yes, it was embodied in the contract.

Q. 29. When I refer to the modification of that contract I refer to plaintiff's exhibit No. ~~1~~? 2

A. Yes.

Q. 30. Now, after this contract was signed and the agreement entered into, did you have any other agreement at any time with the Butte & Superior Copper Company, Limited, with reference to your compensation or remuneration for conducting any operations, save and except the modification of the contract as it appears in plaintiff's exhibit No. 2.

A. There was one verbal modification in this agreement to this extent, that as my actual expense amounted to more than $5.00 a day, and my memorandum

James Macdonald Hyde.

showed that they amounted to more, Mr. Atwater said it would simplify matters if the lump sum of one hundred fifty dollars (which was the maximum amount I was to be allowed) should be paid to me without question.

Q. 31. Was there any other modification of that agreement?

A. None.

Q. 32. Was there any agreement subsequently made about your compensation which was embodied in any other paper than the contract and the modification?

A. None whatsoever.

Q. 33. Now, with reference to the expense money that you have mentioned, could you tell us the cause of that modification?

A. Well, this first amount that I have referred to —I mean this first one in relation to my actual expenses, was when I was at Basin. I had my family with me, and my expenses amounted to more than $5.00 per day, and so it was mutually agreed that instead of presenting the items and the showing of my exact expenses, that the amount would be considered to be $150.00 per month.

Q. 34. I understood you to say in fact that they were more?

A. They were more.

Q. 35. Well—Were you ever at any time in the employ of the Butte & Superior Copper Company, Limited?

MR. GARRISON: That must be a question of law, if your honor please. He has stated what the contract was.

MR. KREMER: I asked the question with design, anticipating the objection.

Objection sustained. Exception.

Q. 36. Were you at any time under salary with the Butte & Superior Copper Company, limited?

A. Will you first tell me what you mean by salary?

Q. 37. Were you ever at any time under an agreement of employment to receive a stipulated sum over a period of time for services to be rendered by you to the Butte & Superior Company?

A. I was not—May I ask you to specify still further; do you mean by that definite amount for a given amount of time?

Q. 38. Yes.

A. I was not.

Q. 39. State to the court what your position was insofar as your arrangements with the Butte & Superior were concerned, in what capacity were you acting?

A. I acted in the capacity that is shown in this contract.

Q. 40. State it, Mr. Hyde?

A. This was a capacity in which I discharged in two stages. The first was to design and superintend the erection of and the operation of a fifty-ton test plant at Basin, Montana, operating the same for

James Macdonald Hyde.

a period of thirty days time. Contingent upon the results of that operation, as shown by this contract, the superintendent of the company had a right to declare the result unsatisfactory and terminate all arrangements between us; and I had a right, if the results were unsatisfactory, to terminate the agreement on the basis that the increased earnings would be so slight that the compensation coming to me would be not sufficient to warrant me in giving my time to the matter.

Q. 41. Well, were you acting as one offering their services for a fixed compensation, or were you acting as an independent engineering cotnractor?

MR. GARRISON: I object to that, if your honor pleases.

MR. KREMER: Upon what ground?

MR. GARRISON: It is a question of law entirely. He has stated he was acting under a contract.

THE COURT: What conclusion should be drawn will appear from the facts, not his conclusion. The objection will be sustained.

MR. KREMER: Proceed, Br. Hyde. Was there any other stage or any other division?

A. The second stage of the operation was that if in the first stage, the test stage, the operations proved sufficiently successful so that the superintendent or executive officer of the company should determine that the company wished to pursue them, I should then plan a larger installation, supervise its installation for a period up to ninety days, giving only such portion

James Macdonald Hyde.

of my time during this ninety days as was actually needed for the satisfactory supervision of the work.

Q. 42. During your dealings with Mr. Atwater referred to, did Mr. Atwater at any time represent to you that he had the power to enter into a contract with you?

A. Mr. Atwater informed me specifically that it was impossible for him to enter into a contract himself; that he could only draw a memorandum of agreement and submit the same to Captain Wolvin, the president of the company in Duluth, Minnesota.

Q. 43. Referring to page 135 of Mr. Atwater's testimony, I read you the following: "Q. What did he say about that? A. You mean in connection with the arrangement which he and I had made? Q. ~~44~~ Yes, in connection with the arrangement that you made with him? A. He asked as part of our agreement that the company stand the expense of any suit that might be brought against him." Did you ever make such a statement to Mr. Atwater? Did you ever make such a request?

A. I have no memory of making any such statement. The only memory that I have is that the matter of possible litigation was discussed. I don't remember whether he mentioned it, or whether I did, but I remember of telling him at that time that if the company were sued it was very natural that they should have to defend themselves, as the total amount of compensation which was being offered to me would be insufficient, of itself, to pay the expenses of a lawsuit.

James Macdonald Hyde.

Q. 45. Was the company sued, to your knowledge, within any time, several years after that?

A. The company was not sued during any portion of the time that I was associated with the milling operations.

Q. 46. Who was sued, if anyone?

A. James M. Hyde.

Q. 47. Now, Mr. Hyde, did you make any statement to Mr. Atwater about patents which you had in contemplation?

A. I told Mr. Atwater that in the course of the tests that I had made upon the Butte & Superior ore I had demonstrated that certain novel features of treatment apparently gave better results than any type of treatment that had previously been used.

Q. 48. What did you say to him with reference to your taking out patents?

A. I told him that I was going to apply for a patent upon these improvements and that the treatment which the application got in the patent office would tend to demonstrate whether the improvements were novel.

Q. 49. Did he ask you why you took out patents on a process when you considered the patents which already existed were of no value?

A. I have no absolute, definite memory with regard to his declaration in the matter, but I know that he did ask some such question. I have a very definite memory of what my answer to it was.

Q. 50. Please state your answer?

A. My answer was this; ~~this~~ that the extended investi-

gation which I had made of flotation patents indicated to me that the patent upon which the claims of Minerals Separation were based was invalid and that the matter in it had been entirely divulged in the United States patent granted to Carrie J. Everson, and in the British patent granted to Alcide Froment.

Q. 51. Did you answer him that you had been advised by counsel to take out that patent at that time?

A. I probably did.

Q. 52. Now, Mr. Hyde, the following I read you from the testimony of Mr. Atwater, page 139 of the record at the bottom of the page: "Q. Did you pay him a flat sum of money per day or did you pay him moneys made up of items of expenses; or both? A. We paid him so much a month." Is that true?

A. There was never any understanding that any sum of money paid on a monthly basis was compensation for services rendered. The understanding was flatly that—as is shown in the contract, which is exhibit 1—that only expenses would be allowed up to the time when the results of the work had demonstrated for themselves what might possibly be done. I will say further with regard to this matter that Mr. R. M. Atwater had requested that I make this investigation for the Butte & Superior Company upon the basis of a fixed compensation and he offered me the magnificent sum of $10.00 per day for making the investigation. I told Mr. Atwater that the compensation was not compensation at all and I wouldn't consider the matter upon any such basis.

James Macdonald Hyde.

Q. 53. Now, Mr. Hyde, I read you the following from the testimony of Mr. Atwater, page 140: "Q. Did you—when did you cease paying him moneys? A. I think when he left Basin. Q. 54. And about when was that? A. That was—why, I think he received a salary after he left Basin. I will correct that. While he was working at Butte on the flotation plant here." Is that correct?

A. I have no memory of having received any regular amount of money in Butte. It is possible that the same allowance of $150.00 per month was made.

Q. 55. Mr. Hyde, please listen to this question and answer what I ask you and as briefly as possible: "Q. And about when was that? A. That was while—why, I think he received a salary after he left Basin. I will correct that. While he was working at Butte on the flotation plant here."

A. I never received a salary under any circumstances.

Q. 56. Then that is not true?

A. It is not true.

Q. 57. Then following, the next question: "At Butte? A. At Butte, I think he received so much a month." Is that true?

A. I haven't any memory of having received any fixed stipulation at Butte.

Q. 58. Well, you would have a recollection, wouldn't you, if you had?

A. I think I would.

Q. 59. Well, do you know whether you would or

not, Mr. Hyde? Do you remember receiving the money?

A. Well, my memories in regard to the matter are simply that I received this allowance up to five dollars a day of expense money while at Basin and only expense money that came from my expense incurred in other ways afterwards.

Q. 60. Have you examined the copies of the vouchers set forth in the table of exhibits?

A. Only very cursorily.

Q. 61. Have you, Mr. Hyde?

A. I have.

Q. 62. Do you recollect receiving the sum specified in those vouchers?

A. They seem to be sums which I have received.

Q. 63. Do you desire to comment upon any of them, Mr. Hyde?

A. Why, those that I recognize are for expenses incurred in traveling. They are not for expenses—and I see an item for the Thornton Hotel which is one of the visits which I made to Butte.

Q. 64. I deliver to you for inspection and comment defendant's exhibits 166, 167, 168, 169, 170, 171, 172, 173, 174 and 175, and I will ask you, Mr. Hyde, to briefly comment upon any one of these that you desire to mention specifically.

A. The first one at hand is voucher defendant's exhibit 166, expense account for July, 1911, at $5.00 per day, one third payment on test machine $10.00. The next one is exhibit—

James Macdonald Hyde.

MR. GARRISON: These are all described in the minutes.

(Question read as follows: "I deliver to you for inspection and comment defendant's exhibits 166, 167, 168, 169, 170, 171, 172, 173, 174 and 175, and I will ask you, Mr. Hyde, to briefly comment upon any one of these that you desire to mention specifically.")

MR. KREMER: Any one of them, if there is any one of them that you think needs any comment?

A. I see none of them that needs comment.

Q. 65. I hand you defendant's exhibit 176 and ask you if there are any comments you desire to make upon that?

A. This is for an expense account you see.

Q. 66. Did you receive the expense account?

A. I have no definite memory of so doing but as it is my signature I have no doubt that I did.

Q. 67. Now, proceeding, Mr. Hyde, I will ask you in what countries, if any, you have procured letters patent, of your patent 1022085?

A. Letters patent were issued to me in the United States, and upon the equivalent subject matter in Canada, Mexico and Australia.

Q. 68. In Australia, did you say?

MR. GARRISON: He did.

A. Yes.

Q. 69. MR. KREMER: Do you know whether flotation operations had been conducted or originated in Australia long before the filing of your patent?

A. There had been.

James Macdonald Hyde.

Q. 70. To what extent do you know?

A. The principal development of the art previous to 1911 took place in Australia.

Q. 71. Now, Mr. Hyde, what, if any, other agreement did you have with the Butte & Superior Copper Company, Limited, if any, than the ones you have referred to here?

A. I had a certain agreement with the Butte & Superior Company made after I was sued for infringement of United States patent 835,120, that for and in consideration of the granting to them any rights that I might obtain by United States patent to the procedure that I was using in treating ores, and for the further consideration of not competing in any way with them in the Butte district, they would pay the expenses of the litigation.

Q. 72. For whom?

A. For me.

Q. 73. Was there any other consideration of the license or right which you refer to than the consideration of the paying of the expenses of your litigation?

A. No. They were to pay the expenses of the litigation and of myself in travelling during the litigation.

Q. 74. Who had the direction or handling of your litigation?

A. I did personally.

Q. 75. Did the Butte & Superior Copper Company, Limited, or the Butte & Superior Mining Company at any time have direction or control of the suit of Minerals Separation, et al. vs. James M. Hyde?

James Macdonald Hyde.

A. They did not.

Q. 76. Please state to the court who, if anyone, had the right to withdraw your defense in the suit of Minerals Separation, Limited, et al. vs. James M. Hyde?

A. There never was anyone who had that right but myself.

Q. 77. Who, if anyone, had the right to make a settlement or adjustment of the controversy existing between yourself and Minerals Separation, Limited, et al., as set forth in the suit of Minerals Separation, et al. vs. James M. Hyde?

A. No one but myself.

Q. 78. Who, if anyone, had the right or authority, aside from yourself, to direct the method of manner of procedure or the litigation in the case of Minerals Separation, et al., v. James M. Hyde?

A. No one.

Q. 79. What, if any, connection did the Butte & Superior Copper Company, Limited, or did the Butte & Superior Mining Company have with the suit of Minerals Separation, et al., vs. James M. Hyde, that being the case that I have constantly referred to as having gone to the Supreme Court?

A. They had no connection with it whatever, other than referred to in the contract with me to pay the expenses of the litigation, which I have mentioned.

Q. 80. Did they so pay the expenses?

A. So far as I know they did.

Q. 81. Who had the direction and control of the lawyers representing you in the case of Minerals Separation, et al., v. James M. Hyde?

James Macdonald Hyde.

A Counsel were selected by myself personally, and the counsel informed me that to a very unusual degree I set with them at all times directing the line of questions that should be asked and worked out the line of tests that should be introduced in evidence.

Q. 82. Did anyone purporting to be the representative of the Butte & Superior Mining Company give counsel or direction, to your knowledge, to your lawyers; or did you do so yourself, exclusively?

A. To my—I have no knowledge of anyone but myself ever counselling them as to what course of action should be taken.

Q. 83. You engaged as one of your lawyers a practitioner who also represents the Butte & Superior ~~Copper~~ Company, Limited, did you not?

A. I did.

Q. 84. I wish you would state the circumstances of that employment?

A. When the Butte & Superior Company agreed, for the compensation which I have mentioned to bear the expenses of the suit, I went to Mr. J. Bruce Kremer of Butte and asked him if there was any reason why he could not represent me as counsel. He replied that there was not. I asked him if there were any reasons in his connection with anyone that would in any way interfere with his representing my interest as though they were the sole interests that he represented in his whole practice and he said that so far as this litigation was concerned there was not. I thereupon retained him to act as counsel for me in this litigation.

James Macdonald Hyde.

Q. 85. Did you engage anyone else?

A. I did.

Q. 86. Who?

A. I engaged the firm of Sheridan, Wilkinson, Scott & Richmond.

Q. 87. Under what circumstances?

A. I discussed the matter with Mr. Kremer and asked him what he would advise in the circumstances and he told me of the fact that he was a corporation attorney and in the general practice of law, and was not in any sense a patent attorney, and that he would feel no more competent to undertake the work of the defense of a patent suit than he would to engage in the practice of the Admiralty law; and he suggested that we find out who would be best equipped to represent us in this particular matter. When I say "us" I mean myself as client and he as counsel. He made inquiry from Mr. D. C. Jackling, a man of great ~~prominence~~ experience, and Mr. Jackling suggested that he had known Mr. Sheridan very favorably, and we made a trip to Chicago. Mr. Sheridan being away we discussed the matter with Mr. Walter A. Scott. I remember after our interview with Mr. Scott we retired and discussed the matter between ourselves, and as a result of our discussion we decided that he seemed to be a man who was particularly equipped to conduct the defense of an action of this kind.

Q. 88. And that was then the beginning of the employment of all of your counsel?

A. Yes, sir.

James Macdonald Hyde.

Q. 89. From that time on who directed the conduct of your case to these counsel?

A. I did personally.

Q. 90. Could you at any time, Mr. Hyde, of your own volition, have discharged any and all of your counsel and employed new ones?

A. There was no time up to the present time when I could not have discharged counsel and taken new ones; and it is ~~might~~ my right today and my sole right to appeal for a rehearing of my case in the Supreme Court and to retain as my counsel there either the learned counsel whom I have had or any other counsel whom I may select.

Q. 91. Now, Mr. Hyde, there is among the exhibits some correspondence with reference to the matter of your settlement and adjustment with the Butte & Superior Copper Company, Limited, of the amount due you or claimed to be due you under the contract in evidence. I wish you would briefly explain that correspondence. I think you have examined the documents?

A. The principal document here is a letter from James M. Hyde addressed to N. B. MacKelvie.

Q. 92. Just give the number of the exhibit so opposing counsel can follow it.

A. That is a letter appearing upon page 25 of the volume of exhibits which I have here in hand. It is dated July 15th, 1913.

MR. KREMER: You needn't read it all, Mr. Hyde, if you have read it.

James Macdonald Hyde.

A. This is a very full statement and it seems to me needs very little elucidation. It is a complete statement of the history of the relations between myself and the Butte & Superior Company, of the conditions which we recognized in the work and throughout my relation to the company is always referred to on the basis of the contract, the contract being that which was introduced here as an exhibit.

Q. 93. Was there any difficulty between yourself and the company, or in the controversy between yourself and the company as to the settlement of your compensation?

A. There was.

Q. 94. Please state the circumstances surrounding that?

A. The original agreement—

Q. 95. Just briefly, Mr. Hyde?

A. (Continuing)—was entered into upon a basis that a 90 day period of work at Basin, on the basis of certain experiments being made and certain machinery, should really bring our agreement to a termination, and the company did not see fit to carry out the agreement and install the machinery that was called for at Basin. Therefore, the final adjustment had to be deferred until after the mill was built in Butte and put into such shape that it carried out the recommendations that had originally been made for Basin. There was considerable delay in carrying out these recommendations.

Q. 96. And upon the matter of settlement?

James Macdonald Hyde.

A. The matter of settlement was a matter of a number of conferences, one of them taking place here in the city of Butte, in which Mr. J. Bruce Kremer represented the Butte & Superior Company, telling me at that time that I must recognize while he was my counsel in the patent matters that in the matter of this agreement with the company which had been specifically referred to him by Mr. MacKelvie, he was the counsel for the Butte & Superior Company and would have to act in their interest.

Q. Did he make any suggestion to you as to the employment of other counsel?

A. He made the suggestion to me at that time that if I felt if it was necessary for me to take any legal action, he would advise it would be necessary for me to have other counsel and he recommended to me, not in his capacity as an officer of—officer representing the Butte & Superior Company, but in his personal capacity as a friend, that the argument be settled, not upon the basis of the contract, but upon a mutual understanding taking everything into account.

Q. 97. You say as "an officer of the company".

A. I mean as counsel for the company.

Q. 98. And was that done ultimately?

A. Yes, that was done ultimately.

Q. 99. And a satisfactory adjustment was made?

A. A satisfactory adjustment was made.

Q. 100. Now, Mr. Hyde, you stated that this arrangement was made between yourself and the Butte & Superior Company with reference to the defense of this suit. With whom did you make that contract?

James Macdonald Hyde.

A. That contract was made with Captain Wolvin personally, he being at that time president of the Butte & Superior Company.

Q. 101. You further state, I think, that it was in consideration of the settlement—of the assignment of certain rights. Did you actually make an assignment?

A. That assignment was made after the patent was duly granted.

Q. 102. And recorded in the Patent Office?

A. So far as I know it was. I instructed my counsel to record it.

Q. 103. Now, Mr. Hyde, it is averred in the pleadings here that your patent No. 1022085 for the concentration of ore and retreatment of concentrates, is a sham patent and that it discloses no invention. I will ask you to state whether that patent is a patent of practical utility?

A. I had a rather unusual experience in applying for that patent in that I went in person, with Mr. Scott, to the patent office and took the matter up with Mr. Mitchell, who was examiner in that division, and Mr. Mitchell told me at the time of our first talk with him—

MR. GARRISON: I hardly think we ought to have what Mr. Mitchell told him.

MR. KREMER: You needn't state what Mr. Mitchell said. You can state what you did.

A. The matter was presented there in person and was granted very shortly. The patent covers two main features of operation, one being the use of sul-

James Macdonald Hyde.

phuric acid, not in the manner in which it had been previously used, that of adding it directly in large quantities into the machine, but of adding a much smaller equivalent, allowing a space of time to elapse so that the smaller amount, acting in the more dilute solution, would have a greater length of time in which to perform its function, and bringing the pulp to the machine and treating it. It covered a second matter, that not of—as has been represented—not the practice of retreatment but of a special method of retreatment and cleaning of the concentrate, that special method consisting of the running of the pulp through a machine in which the attempt was made to eliminate and save the concentrate, the sulphide, as completely as possible, without regard to the commercial grade of the concentrate, and the then taking of that low grade of concentrate from the first machine, which was, because of its function, called a rougher, and taking the concentrate to a second machine and therein making a high grade concentrate. This method was described in the patent in detail as being one in which the water level in the rougher should be kept at such a level that the concentrate would overflow most rapidly and most completely, even if some of the water and slimes overflowed with it. And in the second machine to mantain the water level at so low a point that only the concentrates would overflow, The tailings from the first machine being returned to the first or the recleaner or a grinding device before coming back for retreatment. This patent occupies a peculiar position in

P. 3973, L. 28, insert "procedure? A. The matter of procedure that was outlined and carried on in this machine. Q. 107. Well, not in any detail, Mr. Hyde. It is in the letter; But what I wanted particularly was the matter of" after "of"

P. 3972, L. 5, insert "amount of sulphuric acid or some" after "smaller"

James Macdonald Hyde.

the many patents which have been granted in the flotation work insofar that it is more specific in its disclosure; gives more instructions which can be followed by a millman, and in the body of the patent relates results which have actually been accomplished in the operation of the patent upon a commercial scale.

Q. 104. Where was that being operated; where was it operated?

A. That process was first operated, to my knowledge, at Basin, Montana, and so far as I know, has been continually operated by the Butte & Superior since that time.

Q. 105. Now, Mr. Hyde, did the company ever make any arrangement with you or ever in any manner or form agree to hold you harmless in damages in any litigation or in connection with any litigation?

A. The company did not, and it was a matter of great personal relief to me—

MR. GARRISON: I object, if your honor please, to his state of mind. I can't see that that is material.

THE COURT: I think you have answered the question.

A. There was one point of procedure, you asked me to discuss this here. Do you wish one comment upon it?

Q. 106. MR. KREMER: What was that, in the matter of your settlement and adjustment? I read you from the testimony of Mr. Atwater: "Q. Could you discharge or could you have, in your judgment, have discharged Mr. Hyde? A. Yes. Q. As an employer?

A. Yes, at that time I could have. Q. Upon what basis do you make that statement, the contract? A. I based it upon the fact the president asked me why I didn't tell him, the president of this company." At any time did Mr. Atwater ever say to you that he could discharge or employ you?

MR. GARRISON: I object. There isn't the slightest intimation in Mr. Atwater's testimony that he conveyed any such suggestion to this witness.

THE COURT: I think the witness Atwater testified he could discharge him and then gives a reason which shows that he couldn't. It looks that way.

MR. KREMER: With that in mind, if that is the interpretation, I am perfectly willing to let it rest. I wanted to ask him because I thought there might be a question about it.

THE COURT: You may ask the question if you desire, if he could have discharged him?

MR. KREMER: Could he have discharged you?

A. He could not. There was nothing to discharge me from. I was carrying out a contract.

MR. KREMER: May it please the court, I offer in evidence an assignment, a certified copy of an assignment, of patent, the rights to patent 1022085, as testified to by the witness, this being a certified copy of the patent, of the rights in patent 1022085, filed in the patent office of the United States. Any objection?

MR. GARRISON: No.

Assignment of patent admitted in evidence and marked DEFENDANT'S EXHIBIT 232.

James Macdonald Hyde.

Q. 108. MR. KREMER: Mr. Hyde, I offer you defendant's exhibit 178, a part of which is composed of a purported copy of a telegram sent to you by N. B. MacKelvie from Berkeley, California, reading as follows: "Have received word of decision from Kremer but no details. I take for granted that appeal will be filed. Am at your service for any conference the occasion may require. Will expect matters under discussion to be held in abeyance until new and unexpected situation is taken care of. (Signed) James M. Hyde, telegram dated July 30th, 1913." I will ask you to examine that telegram and instruct the court to what it refers?

A. I judge from the date of this that it refers to the decision of the Montana District Court in question. The only way I can comment upon this thing is by giving my state of mind which has been objected to.

Q. 109. No. don't give your state of mind, but you can state what you meant by it.

MR. GARRISON: I don't know, if your honor pleases.

MR. KREMER: Oh, yes.

MR. GARRISON: Just a minute. I will address the court. I object to this witness testifying what he meant unless there is something obscure. Of course if there is some word that is obscure that is another matter. We are quite as competent to tell what a man says as he is.

MR. KREMER: We have a right to explain.

THE COURT: There is nothing in it to explain.

MR. KREMER: What it refers to, this line, it doesn't mean anything.

THE COURT: He has already said it referred to the decision of this court, which apparently or possibly came about that time. The objection will be sustained.

MR. KREMER: Exception.

Q. 110. What is meant by the statement with reference to appeal?

THE COURT: Oh, well, that shows for itself. We all know that there was an appeal.

MR. KREMER: There was an appeal but that is not in this record, the statement as to his directing the appeal.

THE COURT: You may ask him in reference to that whether he did direct the appeal.

Q. 111. MR. KREMER: Referring to the appeal mentioned in that telegram, who directed that appeal to be taken?

A. I did.

MR. KREMER: That is all.

CROSS EXAMINATION,

BY MR. GARRISON:

X-Q. 112. When did you leave the employ of the Minerals Separation, Limited?

MR. KREMER: I object to that as not proper cross examination. There is no testimony in this record that Mr. Hyde was ever in the employ of the Minerals Separation, and he was asked no question about that on direct examination. It is improper cross examination.

James Macdonald Hyde.

THE COURT: So far as the court can see, it would seem to be.

X-Q. 113. MR. GARRISON: Were you ever in the employ of the Minerals Separation, Limited?

MR. KREMER: I object to that as incompetent, irrelevant and immaterial, having no bearing upon the issues in this case and not proper cross examination.

THE COURT: It might be the relation between the parties. I assume counsel has some object.

MR. GARRISON: I will not consume more than a few moments of the preliminary question.

THE COURT: Objection overruled.

MR. KREMER: Exception.

A. I was.

X-Q. 114. MR. GARRISON: And when did you leave their employ?

MR. KREMER: We object. I suppose all of this will go in under our same objection?

THE COURT: Yes.

A. So far as I remember it, it was the last of January, 1911.

X-Q. 115. And where were you at that time?

A. I was in the city of London, England.

X-Q. 116. Which was the headquarters of the Minerals Separation, Limited, was it not?

A. It was at that time.

X-Q. 117. And you then came from there to what part of this country?

MR. KREMER: Now, we renew our objection to that unless some reason is disclosed, for the purpose

of showing animus. I do not see where it could have any other bearing than that.

THE COURT: I think you may proceed. This is cross examination. To give your reasons does not apply as it does on direct. He has a right to show the relation and attitude of this witness to the parties. The objection will be overruled.

MR. KREMER: Exception.

MR. GARRISON: I merely asked him where he came to in this country.

THE WITNESS: At that time I remained in London.

MR. GARRISON: Read what I said please?

(Question read as follows: "And you then came from there to what part of this country?")

X-Q. 118. MR. GARRISON: You couldn't remain in London and come from there. I asked you after you left London?

A. As I understood the question was as to—

THE COURT: Answer the question.

A. From where?

X-Q. 119. MR. GARRISON: Where did you come to when you left London?

A. I came to New York.

X-Q. 120. And from thence where?

A. I came from thence to Butte, Montana.

X-Q. 121. And when did you get to Butte?

A. I don't remember the date definitely, but it was some time in March or April.

X-Q. 122. Of what year?

James Macdonald Hyde.

A. 1911.

X-Q. 123. And how long were you engaged in the investigation in which you assisted Mr. Kuehn?

A. I have no definite memory of the length of time, but it was some two or three weeks.

X-Q. 124. And were you through the employment in which you had been engaged, assisting Mr. Kuehn in whatever investigation he was making?

A. I was.

X-Q. 125. And you remained in Butte then as I understand it, after that time?

A. I did.

X-Q. 126. And during that period were you making these experiments that you speak of with the Butte & Superior ore. to see whether it was a subject of flotation?

A. As I have testified I was making those experiments.

X-Q. 127. After you and Mr. Kuehn got through and during the time that you remained in Butte?

A. I was.

X-Q. 128. Did you bring a slide machine with you or did you have one constructed here?

A. I had one constructed here.

X-Q. 129. Did you bring one with you?

A. I did not.

X-Q. 130. About when did you have your first interview with Mr. Maxwell Atwater, of which you have testified?

A. While I was making the mine examination I

was meeting Mr. Maxwell Atwater every day, and I have no definite memory when the subject was first mentioned.

X-Q. 131. You have stated that you first had a conversation concerning negotiations with the Butte & Superior with Mr. R. M. Atwater, have you not?

A. I have.

X-Q. 132. And that subsequently you took the matter up with Max Atwater?

A. I have.

X-Q. 133. When was it that you took the matter up with Max Atwater?

A. It was some time subsequent to my conversation with Mr. R. M. Atwater, Mr. R. M. Atwater then not being in Butte.

X-Q. 134. I ask you when it was.

A. I have no definite memory when it was.

X-Q. 135. It was prior to the contract of July 22nd, 1911, wasn't it?

A. It was.

X-Q. 136. Had you any contractual relations of any kind, sort or description with the Butte & Superior Copper Company prior to the contract of July 22nd, 1911?

A. Yes.

X-Q. 137. What previous or other contract had you had with them?

A. I had an agreement with them by which I would make an investigation, for actual expenses, and report to them what probable recovery could be obtained from their ore.

James Macdonald Hyde.

X-Q. 138. When did you make that contract?

A. I have no definite memory, but it must have been in May, I should say, probably.

X-Q. 139. How long did that take you?

A. That took me some week or ten days' time.

X-Q. 140. And you were paid your actual expenses during that time?

A. And nothing more.

X-Q. 141. And that was all through before June, was it?

A. It was.

X-Q. 142. And after that did you have conversations with Mr. Max Atwater about your entering into some other contractual relation with the company?

A. I have no memory of entering into any conversation with him in regard to any other contractual relation with the company than what is set forth in this contract in evidence.

X-Q. 143. Conversations are not set forth in that contract.

MR. GARRISON: Read the question.

MR. KREMER: I object. This is not a proper question. It is not a question at all.

THE COURT: I think that the former question was fairly answered.

X-Q. 144. I understood you that you had some sort of contract with the company that you were to receive your actual expenses while you made some investigations in the month of May, 1911; is that correct?

A. It is.

James Macdonald Hyde.

X-Q. 145. That took you about ten days?

A. That is my present memory.

X-Q. 146. And you were paid your actual expenses for those ten days?

A. My actual expenses.

X-Q. 147. Did you after that time have conversations with Mr. Max Atwater about entering into same other contractual relation with the company. This can be answered, it seems to me, yes or no.

A. Yes.

X-Q. 148. You did?

A. Yes.

X-Q. 149. Now, during that time did you take up with Mr. Max Atwater the patent situation, the Minerals Separation patent situation?

A. I have no memory of going into it with him in any detail.

X-Q. 150. Mr. Nutter was here representing Minerals Separation Company and trying to get the Butte & Superior to enter into a contract with his company, wasn't he?

A. He was. I don't say that from anything more than the knowledge of what Mr. Nutter told me, that he was.

MR. KREMER: We move to strike out the answer as improper, not being from any knowledge of the witness, and being mere hearsay.

THE COURT: It may be stricken.

X-Q. 151. Did you or did you not know that Minerals Separation Company was trying to get the Butte

James Macdonald Hyde.

& Superior Company to take a license from it at that time; did you or did you not know at that time?

A. I had not any definite knowledge in the matter.

X-Q. 152. Did you have some indefinite knowledge?

MR. KREMER: That is objected to as argumentative. If he has no definite knowledge he can have no knowledge.

THE COURT: Well, I granted the motion to strike that, but if it is merely to bring home to this witness the fact that he had information that negotiations were pending, I think it is proper and the objection will be overruled.

MR. KREMER: I will take an exception, if the court please. I desire to make the further objection that the question is argumentative, and does not convey to the witness anything which he could answer. Who is going to judge whether his knowledge is definite or indefinite?

MR. GARRISON: The witness.

THE COURT: He may answer.

Defendant excepted.

THE COURT: He left the inference that he had such knowledge, when he qualified his former answer.

X-Q. 153. Did you have any indefinite knowledge?

A. I did.

X-Q. 154. You knew Mr. Nutter?

A. I did.

X-Q. 155. You met him there?

A. We lunched together and talked over a good many matters.

James Macdonald Hyde.

X-Q. 156. You knew he represented the Minerals Separation Company, Limited?

A. I did know that, yes, sir.

X-Q. 157. Then, as a matter of fact, based on such facts as we commonly base our every-day transactions on in life, you knew he was here trying to get that business, didn't you?

MR. KREMER: That is objected to as argumentative, interpolating the matter about what we base our every-day actions in life on.

Objection ~~sustained~~. overruled

A. The basis of my knowledge was that Mr. Nutter asked me what he should do under the circumstances.

X-Q. 158., And you knew in a general way that he was here trying to get them to enter into a contract with his company, didn't you?

A. I did.

X-Q. 159. Now, you disclosed to somebody representing the Butte & Superior that there were these patents in the offing, didn't you?

A. I have no definite memory as to what was said on that matter. I know that the subject was mentioned.

X-Q. 160. And of course you mentioned it, didn't you?

A. I believe that Mr. R. M. Atwater first mentioned the subject to me, and told me that he had received information in New York that the patents were invalid.

James Macdonald Hyde.

X-Q. 161. You talked over with him whether ~~they~~ they were valid or not, didn't you?

A. I did.

X-Q. 162. And you talked it over with Mr. Kremer, didn't you?

A. I have no memory of talking it over with Mr. Kremer. I met Mr. Kremer only in the matter of making this contract.

X-Q. 163. You never met Mr. Kremer until you met him in connection with that contract?

A. That is my memory.

X-Q. 164. And up to that time had there been any other local counsel or attorney of the Butte & Superior with whom you had come in contact?

A. None.

X-Q. 165. Was the firm of which Mr. Kremer is a member the only local counsel of the Butte & Superior with whom you ever came in contact?

A. It was.

X-Q. 166. Now, to your knowledge did not the company refer the matter of the patent phase of this situation to Mr. Kremer?

A. I have no memory in the matter whatsoever.

X-Q. 167. And you never did have any knowledge to that effect?

A. I never did. ~~I do not remember of having had any knowledge of the matter~~.

X-Q. 168. And you never had any knowledge that Mr. Kremer had referred the matter to a firm of prominent patent lawyers, did you?

James Macdonald Hyde.

A. I never did. ~~I do not remember of having had any such knowledge.~~

X-Q. 169. And he never told you who they were, did he?

A. I do not remember that he ever told me that he had referred any matter to any firm.

X-Q. 170. Did he ever tell you whether he had reached any conclusion as to whether there was any danger of litigation from Minerals Separation if they used this process?

A. I have no memory that he ever did.

X-Q. 171. Don't you remember that he never did?

A. No, I cannot say that I remember that he never did.

X-Q. 172. What is the state of your memory about that?

A. It is simply that I remember nothing in regard to the matter.

X-Q. 173. Is that your signature?

A. It appears to be.

X-Q. 174. Well, is it?

A. Well, all that I can say is that it appears to be.

X-Q. 175. That is the best that you can say after looking at it?

A. I think it is my signature.

X-Q. 176. Have you any doubt about it?

A. No, I have not.

X-Q. 177. Why don't you say frankly that it is your signature, then?

MR. SHERIDAN: I object to this attempt to bluff the witness, if the court please.

James Macdonald Hyde.

MR. KREMER: He can't bluff him.

THE COURT: No, I don't think it is bluffing. If the witness is confronted with his signature he ought to know whether it is his or not.

A. I have no doubt that it is my signature.

MR. GARRISON: I offer this in evidence.

MR. KREMER: We object to it as incompetent, irrelevant and immaterial and tending to prove no issue in this case and in no wise binding upon this defendant. This is a letter written by Mr. Hyde to Mr. W A. Clark, Jr. It is not binding on the defendant.

THE COURT: It is in connection with his testimony as to what he was doing at the time. The objection will be overruled.

Defendant excepted.

Letter referred to admitted in evidence marked PLAINTIFF'S EXHIBIT No. 233.

X-Q. 178. After you had talked to Mr. Max Atwater, after these preliminaries in May had been disposed of, did you and he reach an understanding?

A. The understanding which—

X-Q. 179. Answer my question yes or no; did you and he reach an understanding? Now, you either did or you didn't.

A. We did.

X-Q. 180. And in the course of those conversations with Mr. Atwater did you suggest to him that if suits were brought in connection with the introduction of

this flotation process, that the company must take care of them?

A. I have no memory in regard to that, other than what I testified to on direct examination, that it has been in my mind that I told him that if the company were sued—I had no thought at the time of anybody but the company being sued—that if the company were sued that they would naturally have to defend themselves.

X-Q. 181. Naturally. It was not to be expceted that you would finance the company, was it, that was not expected by you or by them?

A. There was no expectation in the matter.

X-Q. 182. Now, the thing that you really were talking about was in case suit was brought against you, wasn't it?

A. It was not, no. It was an utter surprise to me when the suit was brought against me personally.

MR. GARRISON: I object to this being a surprise to him.

MR. KREMER: He asked him what he thought.

MR. GARRISON: No, I didn't.

THE COURT: Wait a minute; repeat the question and the answer. The answer may be stricken out, after the words "it was not."

X-Q. 183. Do you mean to say that you and Mr. Atwater, or you and Captain Wolvin, if you ever had any conversation, did not talk about what would happen if suit were brought against you?

A. I have no memory of that matter ever being brought up.

James Macdonald Hyde.

X-Q. 184. Then the understanding you had of it with them was that if these threats of litigation were made good, that they would have to take charge of it and pay for the expenses thereof, is that right?

A. If they were sued.

X-Q. 185. Now, that you talked over with Mr. Atwater, did you?

A. I have no definite memory about the matter.

X-Q. 186. Don't you remember getting Mr. Atwater to write a letter stating that that was what you insisted upon, and that you would not enter into any contract until that was understood?

A. I really have no memory of any such letter.

X-Q. 187. Well, do you remember that you had a thorough understanding about that before you would enter into any other contract with them, don't you?

A. No, I don't remember that.

X-Q. 188. Well, do you have any memory at all of ever having talked this over with anybody?

A. My memory is what I have stated it to be, that the matter was discussed, and that as far as I have any memory at all, it was entirely upon the basis that if they—

X-Q. 189. I did not ask you that; I ask you if you do remember talking it over with somebody, and you say you do.

A. I remember the subject having been mentioned.

X-Q. 190. Who do you remember having mentioned it with?

A. I discussed this matter—I mean my whole rela-

tionship was discussed, as far as I remember, only with Mr. R. M. Atwater or Mr. Maxwell Atwater.

X-Q. 191. Then you did talk it over with one of them—one or the other of those two genelemen?

A. I presume it was mentioned to one or the other.

X-Q. 192. And was it one or the other of those gentlemen to whom you conveyed the information that if suit was brought against the company, as you say, that they must pay the expenses of it?

A. I have no definite memory in the matter outside of that I have a feeling that there was such a conversation.

X-Q. 193. And you have stated that in that conversation you said that if suit was brought against the company that they would have to bear the expense thereof; that is what you have said?

A. I think you misquote me.

X-Q. 194. Well, I won't misquote you. What did you say?

A. I say that I have a hazy memory that the subjest was discussed, and my memory is that it was a subject of discussion as I have expressed it.

X-Q. 195. Now, is that the only conversation that you ever had with anybody representing the Butte & Superior Company about the payment of the expenses of litigation?

A. No, there is the one which led to the agreement that on the assignment of my patent rigths they would assume the expense of the litigation.

X-Q. 196. And about when was that?

James Macdonald Hyde.

A. That was some time in October. The exact date is, as I remember, that of one of the letters which is here as an exhibit.

X-Q. 197. October of what year?

A. 1911.

X-Q. 198. Immediately after the suit was brought, or before?

A. I think that it was about one week after the suit was brought.

X-Q. 199. And who did you have that understanding or agreement with?

A. With Captain Wolvin, the then president of the company.

X-Q. 200. You had not applied for any patents at that time, had you?

A. It was—

X-Q. 201. No, no, answer my question.

A. I don't remember the date of my application for patent.

X-Q. 202. Well, let us get the date of your application for patent. I show you the official records of the Hyde suit. Is this the patent about which you have been speaking, No. 1,022,085?

A. It is.

X-Q. 203. That has a legend on it, "Application filed November 10th, 1911," hasn't it?

A. It has.

X-Q. 204. Now, that is the patent that you agreed with Captain Wolvin in 1911 that you would assign him an interest in, is it?

A. It is.

X-Q. 205. The egg had not been laid, much less the chicken hatched, at that time, had it?

A. The process was in operation—

MR. KREMER: I move to strike that expression about the egg; I don't think that is proper.

MR. GARRISON: I will strike it out myself. It is a little too obvious, to need stating.

X-Q. 206. Who else was present when you had this conversation with Captain Wolvin?

A. I had two conversations with Captain Wolvin on this subject. The first one was in the office of the Butte & Superior Company, and there were present one or more—I think either two or three of the then directors of the company, who were present from Duluth.

X-Q. 207. You knew, when you installed or started to install, or started to make available for the benefit of the Butte & Superior the knowledge that you had of flotation, that a patent suit would be brought by Minerals Separation against somebody or other to try to stop that, didn't you?

A. That was an impossibility, my having such definite knowledge.

X-Q. 208. I call your attention to page 38 of the book that you have there in your lap, which is Plaintiff's Exhibit No. 8, a letter written by you to the president of the company, Mr. MacKelvie, under date July 15th, 1913. You did not have any hesitancy there—to show what a positive state of knowledge you had.

James Macdonald Hyde.

You said "The fact that a suit would result from proceeding to use a flotation process was known to all concerned." Weren't you one of the persons concerned?

A. I was.

X-Q. 209. Then you knew it, didn't you?

A. I did not know it in the sense that I could swear to it in a court of law.

X-Q. 210. Oh, I see you draw a distinction there—

Whereupon further hearing was adjourned utnil Monday, May 7th, at 10 a. m.

Monday, May 7, 1917, 10 a. m.

JAMES MACDONALD HYDE resumed the stand for further

CROSS-EXAMINATION.

THE WITNESS: If your honor pleases, if it is permissible I would like to correct my testimony in a few places where I see I was in error on Saturday, in testifying from memory with regard to things six years ago. Page 1929, question 84, in answer with regard to the employment of Mr. Kremer as counsel, I find that I was mistaken as to the date, that it was some time preceding August 18, about the middle, some time preceding the middle of August.

X-Q. 211. MR. GARRISON: What year?

A. 1911. On page 1949 and going on to page 1950 my answer to question 167 should have been: "I have no memory in the matter whatsoever."

X-Q. 212. MR. GARRISON: You said here, "I have knowledge in the matter."

A. I should have said "I have no memory in the matter." The next question I said I never did, where I should have said "I don't remember having had any knowledge of the matter." The next question I said I never did where I should have said "I don't remember of having—

MR. GARRISON: I don't understand that this is correcting his testimony.

THE COURT: I think so.

MR. GARRISON: He says in answer to a question, that he never did. Now he says he should have answered it another way.

THE COURT: I think he has a right to say he made a mistake.

MR. GARRISON: I thought he was merely correcting his English.

THE WITNESS: No, I meant to say I made a mistake. 168, where I said I never did, I should have asid "I don't remember of having had any such knowledge. 169 I say, "He never told me that he had referred any matter to any firm." I should have said "I don't remember that he ever told me that he had referred any matter to any firm.

X-Q. 213. MR. GARRISON: Is that all?

A. Yes, sir.

THE COURT: You may proceed with the cross-examination.

X-Q. 214. I don't think that you have stated your residence and occupation. Will you please do so?

James Macdonald Hyde.

A. My present residence is Palo Alto, California, and I am a mining engineer.

X-Q. 215. And did you come here upon this occasion, the occasion of this trial, of your own impulse, or were you requested to come?

A. I received a telegram requesting me to come.

X-Q. 216. Someone representing the defendant?

A. Yes.

X-Q. 217. And how long have you been here?

A. I think I got here at the end of the first week of the trial. I don't remember the date.

X-Q. 218. You have been here for two or three weeks?

A. Yes.

X-Q. 219. When was the experimental plant at Basin finished?

A. I think it was in June.

X-Q. 220. The experimental plant?

A. Either June or July.

X-Q. 221. Well, if that is so, I will have to clarify my memory and your own testimony respecting the preceding events. Is it correct that your first contractual arrangements with the Butte & Superior were some time in May of 1911 when you made some tests of their ore to see what results you could get from that?

A. That is as I remember it.

X-Q. 222. And that was all done in the month of May?

A. As I remember it.

James Macdonald Hyde.

X-Q. 223. And your understanding was that if, upon your report of the results of these tests, they chose to make a proposition to you, you would say yes or no to their proposition?

A. That was the understanding.

X-Q. 224. And that proposition is what is contained in the contract of July 22nd, 1911?

A. If that is the date of it, it is possible that the events took place in June rather than in May.

X-Q. 225. That what events took place in June rather than in May?

A. The testing of the machinery upon which—I mean the testing of the ore upon which the original report was made.

X-Q. 226. Well, now, I want to get that out of the way; that is done and ended?

A. All right.

X-Q. 227. And as a result of that they made you a proposition which was represented in the contract of July 22nd, 1911, isn't that correct?

A. That is correct.

X-Q. 228. Therefore your second employment was —or if you don't like the word "employment" your second contractual relations with the Butte & Superior dated from the written contract, did it not?

A. That is true.

X-Q. 229. And that written contract is dated July 22nd, 1911, is that correct?

A. Yes.

X-Q. 230. Now, when was the experimental plant

James Macdonald Hyde.

built under the contract of July 22nd, 1911, finished?

A. My memory of the matter has been that this took place in the month of June and July; it may be that that contract was not signed—and I think that that is the case—that it was not signed by Captain Wolvin until after the agreement had practically been made—I mean an understanding had been entered into between myself and Mr. Atwater.

X-Q. 231. Precisely. That is the fact, isn't it, that what you really did was to have an understanding with Mr. Atwater, and you and he acted on that understanding, and it was not until afterwards that any written paper was made by you at all; isn't that the fact?

A. As I remember it, it is.

MR. KREMER: Then you may explain.

MR. GARRISON: Wait a minute. The court will say whether he may explain or not.

MR. KREMER: Then I will ask the court if he may not explain.

THE COURT: Read the question and answer—I do not see that any explanation is needed. The answer is a full answer to the question. When you come to re-examine him you may bring out any circumstances that tend to break the force of that answer if you desire.

X-Q. 232. Now, Mr. Hyde, in confirmation of that fact, please refer to the book of exhibits that you have in your lap?

A. I haven't the book of exhibits with me; I think I left it in my room.

X-Q. 233. Well, we will try and get you a copy. That is exhibit 166, page 82?

A. I have it.

X-Q. 234. You observe that that is a voucher receipted by you for your expense account for July, 1911, at five dollars a day, for 31 days, do you not?

A. I do.

X-Q. 235. So that it is quite obvious from that exhibit and from what you have now testified to that you were working under a verbal understanding with Mr. Atwater for many days before the date of any written contract; isn't that true?

A. It is true that it was before this written contract here, but I believe there was a written understanding between Mr. Atwater and myself, that he had received word from Captain Wolvin that he would sign at the proper time, or when the matter was submitted to him in final form, this agreement.

X-Q. 236. In other words, as I understand you now, you and Mr. Atwater reached an understanding; that was the first thing that was done, wasn't it?

A. He submitted—

X-Q. 237. Wait a minute; if I am wrong say no. Read the question.

A. We reached an understanding.

X-Q. 238. Then Mr. Atwater communicated with his principals, whoever they were; that is correct, isn't it, or he told you he had?

A. I believe he did.

X-Q. 239. And he told you that you and he would

James Macdonald Hyde.

go ahead under your verbal understanding, isn't that correct?

A. I think that that is correct.

X-Q. 240. Now, when was that experimental machine, thus being fixed up, actually completed and work done on it?

A. I haven't a definite memory as to that matter.

X-Q. 241. Well, it was about the first of August, wasn't it?

A. My memory was that it was earlier than that.

X-Q. 242. At or about the first of August then?

A. At or about, yes.

X-Q. 243. And you made the runs on it, to demonstrate whether or not it would produce the results, did you not?

A. I did.

X-Q. 244. And those runs were successful enough to induce the company to go on with the rest of the understanding about the larger plant?

A. They were.

X-Q. 245. Now, under your contract, the sums of money that you received—this sum of $5.00 a day, was to be paid you while engaged in mill work in said company's behalf; that is true, is it not?

A. Yes.

X-Q. 246. So that as long as we have vouchers showing $5.00 a day paid to you, you were engaged in mill work in the company's behalf, were you not?

A. Well, I don't know what technical significance

there would be in the statement in that way; I was working under the agreement as shown here.

X-Q. 247. You have had opportunity to, and I assume during the two or three weeks you have been here you have looked over these vouchers, have you not?

A. I have simply gone over them to see that they were vouchers for expenses.

X-Q. 248. Well, but you were informed that you were to go on the stand here and testify to your connection with respect to these matters, were you not?

A. I was.

X-Q. 249. And you had it back and forth between here and your lodging place, day in and day out?

A. I think it has been in my lodging place most of the time, yes.

X-Q. 250. So you have looked it over?

A. I have, yes.

X-Q. 251. So you knew, for the complete month of July, 1911, you received your $5.00 a day, didn't you?

A. I received that expense money.

MR. GARRISON: Now, I ask to have everything stricken out after the word yes or no, as to that.

THE COURT: Well, it is another form of answering the question. Answer it more directly.

A. I did receive that amount.

X-Q. 252. Yes, and you received a similar amount for the month of August, 1911, for the full month, did you not?

A. I did.

James Macdonald Hyde.

X-Q. 253. And for the full month of September, 1911, did you not?

A. As I remember it.

X-Q. 254. And up to the 26th of October, 1911, did you not?

A. I don't remember the exact date, but it was some such time.

X-Q. 255. Well, the vouchers will show. Don't let us have any doubt as to these things. It is on the voucher.

THE COURT: Any time you desire to refresh your memory from them, you may do so.

X-Q. 256. MR. GARRISON: If you will look on page 88, Exhibit 172, you will see the expense account for October, 1911, 26 days at $5.00 a day, $130.00. Now, if you want to look at the one for September, it is on page 86 and is exhibit 170. That is for 30 days of September, is it not?

A. Expense account at $5.00 per day.

X-Q. 257. So that we find from these exhibits that you received your $5.00 a day for July, August, September and 26 days of October? Is that correct?

A. That is correct.

X-Q. 258. And it was, I suppose on the 26th day of October, that you and Mr. Kremer left for Chicago, was it not?

A. I haven't any definite memory as to the date. It was about that time.

X-Q. 259. Now, did you ever receive any money from the Butte & Superior, leaving out these early ex-

periments, those days that you received your actual expenses, not your $5.00 a day, excepting moneys paid in accordance with the terms of the written contract?

A. I received the actual expenses of my traveling when engaged in the patent suit and in such visits as I made to the Butte plant after October 26th.

X-Q. 260. So that, with the exception of what you have just stated, the moneys that you received from the Butte & Superior Company were moneys that were paid to you under the terms of this written contract? Is that correct?

A. Or the supplemental agreement.

X-Q. 261. Or the supplemental agreement, yes; I should have included that. And all moneys paid to you under this contract excepting the $5.00 a day were for your services?

A. The $5.00 a day under the contract as well.

X-Q. 262. Read my question. I didn't say they were not.

(Question read.)

X-Q. 263. MR. GARRISON: And the $5.00, if you wish?

A. And the $5.00 a day.

X-Q. 264. And all the moneys that were paid to you including the $5.00 a day were paid to you for your services? Is that correct.

A. Services and expenses.

X-Q. 265. And with respect to your patent, the number of which has been several times stated during your testimony, will you please give me the names of

the other licensees in the United States outside of the Butte & Superior?

A. There are no other licensees at the present time.

X-Q. 266. Now, you have told us that you had a conversation with Captain Wolvin in October, 1911, in which you and he agreed on this matter of the expenses. Where was that conversation?

A. There were two conversations. The one which I referred to the other day, being the first of the two, was in the office of the Butte & Superior Comapny at the mine.

X-Q. 267. And in your direct testimony you stated that that conversation was had after you were sued for infringement? So it was some time after October 3d, 1911; is that correct?

A. Yes, sir.

X-Q. 268. And was that the first time that you and Captain Wolvin or you and anybody else on behalf of the Butte & Superior Company, had talked over the matter of the defense of any lawsuit to be brought against you?

A. I can't say that it was.

X-Q. 269. Search your memory and tell me whether it was or not.

A. I have no definite memory of any conversation with regard to the matter, but I doubt not that they occurred.

X-Q. 270. Do you doubt that they occurred before this?

A. They must have occurred before that. I don't

James Macdonald Hyde.

remember the date upon which service was made upon me.

X-Q. 271. Well, the bill was filed on the 3d day of October, 1911. Now, then, you were not served until after the bill was filed, or on the same day, we will say, and so we will fix October 3d at the first day you could have been served. Now, did you have any conversation with Captain Wolvin about the payment of expenses of lawsuits prior to the 3d day of October, 1911?

A. I have no definite memory with regard to any. I saw Captain Wolvin very few times.

X-Q. 272. In your examination on Saturday you were asked whether you had not had conversation concerning the payment of expenses and taking charge, etc., of lawsuits against you, and you said that the first time that you had any such conversation was the one that you had with Captain Wolvin after the Hyde suit was brought. Now do you wish to correct that?

A. I have no definite memory in the matter whatsoever.

X-Q. 273. Have you any less definite memory today than you had on Saturday?

A. No. If I made the definite statement that I never had had such conversation I may have been in error.

X-Q. 274. Well, now tell us what this conversation was that you did have with Captain Wolvin in October of 1911 at the office of the Butte & Superior Company.

James Macdonald Hyde.

A. The conversation was upon the date on which the supplemental agreement was entered into; and the main reason for the conference was the entering into that supplementary agreement.

X-Q. 275. Well, now, we will get that date immediately. That was the 26th day of October, 1911.

A. There is a record ~~of~~ in that agreement that a certain payment had been made to me that day, payment under the contract or under this modified contract, and, in the course of the conversation which took place between us I remember of asking Captain Wolvin: "Well, now, what are we going to do about the expenses of this lawsuit which has been brought against me personally?" And he made the reply that if I would agree not to compete with the company in acquiring or operating properties in the Butte district, and would give the company an exclusive license to the Butte district of any rights that I might acquire if I obtained a patent upon the process which I had developed and which I told them had certain novel features, that they would bear the expenses of the litigation.

X-Q. 276. Now, then, had you had any understanding or agreement with anybody on behalf of the Butte & Superior prior to that time concerning the payment of expenses of lawsuits brought against you?

A. As I said before, I have no definite memory of having had such.

X-Q. 277. In your examination on Saturday you stated that you had not had such conversation because

it had not occurred to you that you would be sued or could be sued.

A. I was mistaken in that statement and my memory—as I have thought the matter over I remember that there was a definite statement made to me that I probably would be sued.

X-Q. 278. And when was that definite statement made to you that you probably would be sued?

A. I don't remember whether that statement was made by Mr. Nutter or Mr. Spitzer. Both of them had been here in Butte and had conversation with me on the matter. It would be preceding—it would be preceding the actual filing of the suit.

X-Q. 279. And you stated in ~~cross examination~~ some corrections that you made this morning that you had been to see Mr. Kremer before August 18, 1911; is that correct?

A. That is correct.

X-Q. 280. How did you get that date of August 18, 1911?

A. I asked Mr. Kremer this morning and he said that he remembered that it was previous to that date.

X-Q. 281. He showed you a letter, didn't he?

A. He did.

X-Q. 282. Showed you a letter from Mr. Williams, didn't he?

A. He did.

X-Q. 283. So that it was known by Mr. Kremer as early as August 18 that you were to be sued, and he wrote to Mr. Williams that he was the attorney engaged to defend you, did he not?

A. He did.

X-Q. 284. So that, as a matter of fact you had gone and retained Mr. Kremer's services as early as August 18, 1911?

A. That is why I corrected my answer with regard to the date, this morning.

X-Q. 285. And you did not correct that answer until Mr. Kremer had shown you correspondence between Mr. Williams and himself, did he?

A. Because I had no memory of its being at so early a date.

X-Q. 286. But you had a very distinct memory that you had not gone to see Mr. Kremer until after you were sued, did you not?

A. I did.

X-Q. 287. And that you had a very clear picture in your mind which you conveyed to us of walking into his office and telling him you had been sued and asking him whether he was in a position to defend you, as if it was the sole case in his office, and all of that you told us, did you not?

A. All of this was true of the occasion when I did go to see him and retained him.

X-Q. 288. Yes, but you recited this conversation with dramatic certainty, after you were sued, did you not, you stated that you went down there after you were sued. You were mistaken about that, were you?

THE COURT: You are qualifying the witness.

MR. GARRISON: I will withdraw that question. I think it is objectionable.

James Macdonald Hyde.

X-Q. 289. You had a very clear memory on Saturday of going down to Mr. Kremer's office after you had been sued and having this conversation about his qualifications to take your case; isn't that correct?

A. That is exactly the way in which I remembered it.

X-Q. 290. Now, what was the occasion of your going and engaging Mr. Kremer's services in August, 1911?

A. I don't remember definitely, but I take it for granted that it was the result of having been informed that I would be liable to be sued.

X-Q. 291. At that time you expected to have to bear all the expense of that suit, didn't you?

A. I have no memory as to what I expected at that time.

X-Q. 292. You had a very clear memory on Saturday that up until the service of papers in the suit, it had never occurred to you that you would be sued, and therefore that was the first time you made any arrangements about the expenses of such a suit.

A. I corrected the record this morning, because I found that my memory was not correct on Saturday.

X-Q. 293. When you went to see Mr. Kremer did you ask him what his retaining fee would be?

A. I don't remember of having arranged the matter of the fee.

X-Q. 294. Did you pay him any money?

A. I did not.

X-Q. 295. Well, what did you do with Mr. Kremer

James Macdonald Hyde.

at that time; did you give him the patents of Minerals Separation on which they would be liable to base their suit?

A. I don't know that I gave them to him at that time, but I am very certain that I gave him a record of such patents relating to the whole subject as I had been able to ascertain.

X-Q. 296. At or about that time?

A. At or about that time.

X-Q. 297. Now, previous to this, and when you were in New York, you had gone into this patent situation with Mr. Stone of Hayden, Stone & Company, hadn't you?

A. No, I never met Mr.—

MR. KREMER: I object to that as incompetent, irrelevant and immaterial for any purpose and no connection with this suit whatever.

THE COURT: It is cross examination.

MR. KREMER: The record shows that at that time Hayden, Stone & Company had nothing whatever to do with the company.

THE COURT: I think he may inquire. Objection overruled.

Defendant excepted.

A. I met no member of the firm of Hayden, Stone & Company when I was in New York before coming to Butte.

X-Q. 298. Had you ever gone over this patent situation before you went over it with Mr. Kremer?

A. Why, I had gone over it in my personal study of the matter. I don't know whether I had with anybody else.

X-Q. 299. Had you seen any attorneys about it?

A. No, I had not.

X-Q. 300. Didn't you tell Mr. Nutter that you had seen an attorney about it.

A. I have no memory of telling Mr. Nutter that I had. It is—

X-Q. 301. Go on and make your explanation?

A. I went over the whole details of this thing when I was in London, and as Mr. Herbert Hoover testified in the Hyde case—

MR. GARRISON: This is certainly not in response.

THE COURT: Read the question.

(Question read.)

THE COURT: Answer that question.

A. I don't remember ever having told him so.

X-Q. 302. Now, then, after you had gone and engaged Mr. Kremer's services in August of 1911, you did go over the patent phase of the matter with him, didn't you?

A. I did.

X-Q. 303. And he referred the matter to Sheridan, Scott, Wilkinson & Richmond, or whatever the name of the firm was at that time?

A. I think that is correct.

X-Q. 304. And he informed you that he had done so, did he not?

James Macdonald Hyde.

A. I presume that he did.

X-Q. 305. And you wrote Mr. Clark the letter which I showed you the other day, in which you conveyed that information to Mr. Clark?

A. I did.

X-Q. 306. Then you were entirely wrong in your testimony on Saturday concerning that matter?

A. I was.

X-Q. 307. Now, you knew that a suit of this character would cost a very great deal of money, didn't you?

A. I knew nothing about what the cost would be, but I expected it would be great.

X-Q. 308. What is that?

A. I had no definite knowledge of what such costs might be, but I expected they would be large.

X-Q. 309. Your own guess was that it would be more than thirty thousand dollars, wasn't it?

A. I took it for granted that it would be.

X-Q. 310. More than thirty thousand dollars?

A. Yes.

X-Q. 311. Now, did you have any thirty thousand dollars to spend in a lawsuit to get the privilege to the Butte & Superior Mining Compay to operate without payment of royalty to Minerals Separation?

A. I did not.

X-Q. 312. And in your view—your expressed view —it was utterly unreasonable to expect you to do that, to defend this suit, in order to get them that privilege; isn't that correct?

A. If I had not been able to make the arrangements with them, I would have had to retire from the field.

X-Q. 313. Answer the question please.

(Last question read.)

A. It was.

X-Q. 314. Now, then, at the time that you had entered into arrangements with them in June or July, whenever it was, you talked over this whole question of suits on behalf of Minerals Separation to obtain injunctions to prevent the use of their process, didn't you?

A. I have no definite memory as to what the conversation went into but I know that the matter was discussed.

X-Q. 315. Now, let me help your memory. In exhibit No. 8, page 38 of the book of exhibits, that being a letter from you to Mr. MacKelvie, dated July 13th, 1913, you wrote as follows: "The fact that a patent suit would result from proceeding to use the flotation process was known to all concerned, and the three attorneys upon the old board of directors should have been able to anticipate what the suit would amount to in the way of costs. Our relations were in no way modified by the fact that suit was brought in my name. Its object is to enjoin your company from the use of the process and to compel it to pay a royalty, and is brought against me solely for the performance of acts carried on for your company." Now, all that, you say, was known at the time that you began talking

James Macdonald Hyde.

to these people about selling them whatever information you had concerning flotation processes, wasn't it?

A. It was understood that there would probably be a suit.

X-Q. 316. And it was understood that the company should pay the expenses of that suit, wasn't it?

A. I don't remember the definite—I mean the absolute definite nature of the understanding in the matter.

X-Q. 317. Well, you are drawing some fine line of distinction, aren't you, between whether a thing was stated in certain language or stated in certain other language, isn't that right?

A. No, I am stating the actual ~~situation~~ condition of my memory, that I don't remember the details.

X-Q. 318. I don't ask you for details; I ask you whether, in view of what you have testified here and written here, there was not an understanding—without regard to the express language of that understanding—that if a lawsuit was brought by Minerals Separation Company to prevent the carrying on of this operation at the Butte & Superior mill, that they would have to bear the brunt of that suit; wasn't that your understanding?

A. As expressed in this letter, it is.

X-Q. 319. No, but as your understanding at the time; was that your understanding after you had these conversations with these gentlemen?

A. I don't see that I can add anything to my previous answers.

James Macdonald Hyde.

X-Q. 320. It is because I don't understand you. In this letter of July 13th, 1913, as I understand you now, you were conveying to Mr. MacKelvie what the understanding was at the time you entered into this arrangement, weren't you; isn't that correct?

A. That is what I understood, that they realised ~~realized~~ what the circumstances would bring forth.

X-Q. 321. Exactly; that if a suit was brought that they would have to stand for that suit?

A. I don't remember of there being any definite understanding as to what would happen if a suit were brought against me personally.

X-Q. 322. But the situation was this, wasn't it, that you all knew that a suit would be brought to try to prevent the Butte & Superior Mining Company operating a flotation process claimed to be an infringement of the M. S.?

A. We all knew that there were threats that that would be done.

X-Q. 323. And the understanding that you had was that if that was done the company would have to take charge of any such suit; that you were not going to stand the expenses of such suit?

A. I think they understood that I could not stand the expenses.

X-Q. 324. And it was understood that they would; isn't that correct?

A. I don't remember how far the agreement went as to what they would stand or would not stand, because there was no agreement between the company

James Macdonald Hyde.

and myself at any time that they would fight a suit rather than pay royalty.

X-Q. 325. But if they elected to fight a suit they were to stand the brunt of that, weren't they?

A. Certainly.

RE-DIRECT EXAMINATION,

BY MR. KREMER:

R-Q. 326. Mr. Hyde, referring to the exhibit that Judge Garrison just interrogated you with reference to, wherein you referred to a suit, I will ask you if it is not a fact that you had heard previous to August, 1911, that suit would be brought against the Butte & Superior, and state from whom you heard those threats?

A. I heard those threats from E. H. Nutter, and from a Mr. Spitzer, who, I understood, was connected with the firm of Beer, Sondheimer & Company.

R-Q. 327. Did you ever have an understanding prior to that understanding that you have referred to in your testimony as having been made with reference to the defense of the so-called Hyde Suit—did you ever have an understanding with the Butte & Superior that they would defend the suit if you were sued?

MR. GARRISON: I object to the form of the question.

THE COURT: Yes.

(Question withdrawn)

James Macdonald Hyde.

R-Q. 328. MR. KREMER: Did you ever have an understanding with the Butte & Superior company that they would defend a suit brought against you, prior to the understanding that you have testified that you had with Captain Wolvin?

MR. GARRISON: I object to the form of that question.

THE COURT: Objection sustained.

Defendant excepted.

R-Q. 329. Did you ever have any other understanding with the Butte & Superior with reference to the defense of a so-called suit, than the one you have testified to?

MR. GARRISON: I object to that, if your honor please.

THE COURT: Objection overruled.

Plaintiff excepted.

A. I have no memory of any agreement of that sort.

R-Q. 330. In answer to a question propounded by Judge Garrison you stated that you thought that the expense of defending this suit brought against you, or a suit that might be brought, would exceed $30,000. Will you explain why you thought so, if you can, or how much more than $30,000 you thought it would cost.

A. I had no definite basis upon which to judge as to what the cost of such a suit would be. I had known of certain patent litigation going on, where expert witnesses had been retained, and so forth, and knew that the expenses were very large.

James Macdonald Hyde.

R-Q. 331. Did the expense of that suit have anything to do with the figure mentioned in your contract with the Butte & Superior?

A. As stated in one of Mr. MacKelvie's letters—

R-Q. 332. No, just answer the question, Mr. Hyde.

A. It did not.

(WITNESS EXCUSED).

MR. KREMER: We desire, at this time, if your honor pleases, to offer a certificate from the acting commissioner of patents, accompanying a disclaimer or purported disclaimer, to the effect that no other disclaimer had been filed in the patent office of the United States, save and except the one thereto attached.

Paper admitted in evidence without objection and marked DEFENDANT'S EXHIBIT.

THE COURT: Is it the same disclaimer referred to?

MR. KREMER: Yes, sir.

THE COURT: It is utterly useless.

MR. KREMER: The question is of a negative character, that a search has been made.

MR. WILLIAMS: We will stipulate that no other disclaimer has gone in.

THE COURT: Well, it may go in. When the record is made up a great deal of this will be cut down.

Certificate admitted in evidence and marked DEFENDANT'S EXHIBIT No. 234.

J. T. SHIMMIN, Recalled, testified as follows:

DIRECT EXAMINATION
BY MR. SCOTT:

Q. 1. You have produced papers entitled "Butte & Superior Mining Company", one dated April 28th, and one dated April 29th and one dated April 30th. Are the operations recorded in these reports those which were carried on under your supervision?

A. Yes.

Q. 2. And to the best of your knowledge and belief they correctly represent the results of those operations and conditions under which they were conducted?

A. Yes.

MR. SCOTT: I offer the papers in evidence, the same being the records of the Butte & Superior Mining Company of mill operations on April 28th, 29th and 30th, and we offer them as one exhibit.

Papers admitted in evidence and marked DEFENDANT'S EXHIBIT 235.

CROSS EXAMINATION
BY MR. WILLIAMS:

X-Q. 3. These are the official reports from the records of the company of the proceedings of those three days, is that correct?

A. Yes.

X-Q. 4. On April 30th, the day that we were there, where did you put the oil in?

J. T. Shimmin.

A. I think at the discharge of the tube mill; I am not certain.

X-Q. 5. You don't know?

A. I am not positive, no.

X-Q. 6. On April 28th, the day before we were there, where did you put the oil in?

A. The feed end of the tube mill.

X-Q. 7. It was changed the morning we were there from the feed end of the tube mill to the discharge end of the tube mill?

A. Yes.

X-Q. 8. What are you doing now; feed end or discharge end?

A. Well, in fact I don't know; I think it is going to the feed end.

X-Q. 9. You have been doing that for a considerable time, have you not, putting the oil in at the feed end of the mill?

A. Yes, we have.

X-Q. 10. What kind of tube mills are those which you have?

A. They are the regular—well, they are four and a half by twenty, Denver Engineering Works.

X-Q. 11. Cylindrical?

A. Cylindrical mills, yes.

X-Q. 12. Are they pebble mills or ball mills?

A. The first 16 feet is pebble, and the balance is balls.

X-Q. 13. In the same tube?

A. In the same tube, yes.

J. T. Shimmin.

X-Q. 14. The balls are of what material?

A. Manganoid.

X-Q. 15. Is that a manganese steel?

A. No, it is called manganoid; it is a ball made by the Jeffrey Manufacturing Company.

X-Q. 16. About what is its composition?

A. I couldn't say offhand.

X-Q. 17. It is manganese and iron?

A. I think it is.

X-Q. 18. The name manganoid is just a trade name, isn't it?

A. Just a trade name.

(WITNESS EXCUSED)

MR. SCOTT: That closes our case.

MR. WILLIAMS: There were some particulars that Mr. Dosenbach was to furnish. Hasn't he got them? He was to give an assay of the sulphide ore.

MR. SCOTT: We will ask the court if these assays may not be put in without delaying the matter any further. He didn't have them Saturday.

MR. WILLIAMS: Have you got them, Mr. Dosenbach?

MR. DOSENBACH: I have an assay of the copper sulphate. I haven't an assay of the molybdenite.

BEN H. DOSENBACH, Recalled for further direct examination.

BY MR. SCOTT:

Q. 1. You may state, Mr. Dosenbach, what the assay of the molybdenite ore was that you used in your experiments here in court.

A. I haven't got the correct assay yet but it is approximately what I gave before; won't vary within several tenths of a percent.

Q. 2. Excuse me, I got the wrong one. Well, the sulphate?

A. I have an analysis of the copper sulphate as far as I have it, it is about 1.58% copper; about .3 silver; 3.68 sulphuric acid; 5.79 sodium chloride or salt. I haven't a determination of the iron or the ferric or ferrous salts. This is under the general determination that we make up there, and this is one analysis that I happen to have.

MR. WILLIAMS: That is all.

MR. SCOTT: As to the assays of the samples that were taken from these experiments I take it that you agree that they may go in evidence as soon as we have them?

MR. WILLIAMS: Yes, but Mr. Thomas Janney has not yet been excused as a witness, and I understood from him yesterday that he had to go home because of illness and that he would leave with you certain information which I had asked him for. Have you that?

MR. SCOTT: I didn't see him yesterday.

MR. DOSENBACH: As I understand, you requested for the days the shifts, upon which certain experiments were run and he left that with me so that I can now give it to you.

MR. WILLIAMS: Well, if you will read it in the record, that will be acceptable.

MR. DOSENBACH: The experiment No. 14 was run on the day shift of April 6th, 1917; experiment No. 15 was run on the third shift or the graveyard shift, April 5, 1917; experiment No. 16 was run on the second shift of April 5th, 1917; experiment 28 was run on the third shift of April 8th for the first 4 hours; experiment No. 29 was run on the third shift of April 8th for the second four hours.

MR. WILLIAMS: Experiment 30. Have you got that?

MR. DOSENBACH: That is all he gave me. No, I didn't get any for that, 14, 15, 16, 28 and 29 is the information that he gave me.

MR. WILLIAMS: Now, Mr. Scott, there was an exhibition to our representative of operations of one of the Utah plants and we took specimens and the Utah representatives took specimens. I intended to ask Mr. Tom Janney for the particulars of that day's run. Can you supply us with the actual reports or any particulars?

MR. SCOTT: No, I don't think I have the report. I can probably get it by writing, if you will accept it in that form.

MR. WILLIAMS: I will accept Mr. Janney's statements. I will take Mr. Thomas Janney's statements as the equivalent of evidence.

MR. SHERIDAN: Mr. Frank Janney was there.

MR. WILLIAMS: You are right about that—Mr. Frank Janney.

MR. SHERIDAN: Well, we will wire down to Mr. Frank Janney and get the data.

(WITNESS EXCUSED).

MR. WILLIAMS: Now, your honor, I would like to have a rather distinct understanding as to the testimony of Prof. Taggart in relation to certain tests, followed by some testimony of Frank C. Janney. The ruling of the court was that that testimony be stricken out. The testimony was, of course, written at length by the stenographers in the record. It is my understanding that your honor ordered it to be bodily stricken from the record.

THE COURT: What is that?

MR. WILLIAMS: The experiments made by Prof. Taggart, which your honor struck out as hearsay, on May 2nd, and it appears in the record commencing—Well, I have the details of it—It was an experiment as to which the witness was wholly unable to testify and your honor struck it out as hearsay. Now it is in the stenographic minutes. I would like to know whether your honor wishes it excluded from the record. The defendant reserved a right to make some sort of a statement. Unless, then, the

testimony goes out, and the defendants make some sort of a statement, that is my understanding of the way the record is to be made up. Of course, as a matter of fact, I stopped cross examination when your honor ordered the testimony stricken out.

MR. KREMER: My understanding, if your honor pleases, was that your honor ordered it stricken out and we simply excepted. Then it remains in the record. That is, it is represented in the record, but not in the record for consideration by counsel to such a degree that it calls upon him to cross examine upon it. To all intents and purposes the testimony has been rejected.

THE COURT: I can not see any difference in principles whether it is excluded altogether from the record or left in. There might be, if there was an exception taken. Did you take an exception?

MR. KREMER: There was an exception taken. It merely becomes a part of the record.

THE COURT: When it was ordered stricken, did the defendants take an exception?

MR. KREMER: Yes, your honor.

THE COURT: I think it ought to remain in the record so that if it ever goes to the Appellate Court, if this should have to go up, they would have the benefit of their exception. Otherwise, if we struck it out altogether, the Appellate Court could not say whether it was properly stricken or not. It should remain in in order that they will have the benefit of it. If it remains in the record it would not be

P. 4025, L. 1, insert "considered by this Court, and certainly it would not be"

considered by the Appellate Court more than to consider the question. Of course, since you have not cross examined upon it, it would not determine the question, if it was of sufficient importance to take a note on it. That is the practice here.

MR. GARRISON: Have you closed now, with this exception?

MR. KREMER: We close.

MR. GARRISON: Now, we move to strike out all testimony offered in behalf of the defendant to which we objected on the ground that it was irrelevant and immaterial and incompetent because it did not represent anything in the prior art and did not therefore meet any issue that was raised in this case, and which was admitted by the court upon the promise of the counsel for the defendant that they would connect the testimony with the prior art and therefore make is competent. The motion that I am now making is based upon their failure to make such connection and to show the relevancy and materiality and competency of such testimony by showing that it did represent the prior art, or any part thereof.

THE COURT: Well, to all intents and purposes you are moving to strike out all their testimony?

MR. GARRISON: Of that character.

THE COURT: There is some of it, undoubtedly the court will not take into consideration as not representing the prior art. I do not think the court can grant a motion made in that way. I think we are bound to leave all of this testimony in, and when

we come to make up our decision, as far as it is entitled to weight the court will give it weight, and as far as it is not, the court will not consider it. Of course it will leave the case in such shape that you can for your safety meet any or all of it that you may see fit. The motion will be denied.

MR. GARRISON: Exception.

MR. WILLIAMS: On behalf of the plaintiff, the rebuttal testimony will be opened by evidence of the acquiesence in the patent in suit and of the great utility of the invention, the extensive use that has been made of it, not with any effort to make a complete showing, but to make a sufficient showing as to these facts, and I will first call Mr. Ballott to the stand.

WHEREUPON THE FOLLOWING TESTIMONY WAS OFFERED IN REBUTTAL:

JOHN BALLOT, recalled in rebuttal, testified as follows:

DIRECT EXAMINATION,

BY MR. WILLIAMS:

Q. 1. I wish you would give a list of the licensees in America of Minerals Separation Limited, and Minerals Separation, North American corporation.

MR. KREMER: To which we object for the reason

John Ballot.

that it is incompetent, irrelevant and immaterial and does not tend to prove the charge of infringement.

THE COURT: The objection will be overruled.

MR. KREMER: Exception. And your honor will permit me to add a further objection which I understand Mr. Williams will meet. In connection with these licensees I understand that you are going to produce the licenses?

MR. WILLIAMS: Well, I believe all of the licenses are here. It may be that one or two of the later licenses, which will be in form exactly the same as the others, may not be here.

MR. KREMER: Can you tell us the substance of them?

MR. WILLIAMS: I think we can supply the information that the defendant may want as to the details of these licenses and we have the originals here with will be proffered insofar as necessary, although we hope not to make too large a record in the matter.

MR. KREMER: I will state, to save this time, we assume that some time during the case that these licenses will represent a matter that should have the scrutiny and inspection of the defense, but both for the purpose of showing the so called acquiesence that they claim, and if perchance it should ever become necessary to look to the licenses to see the course and condition of business, they will be available.

MR. WILLIAMS: We will be very much pleased to show how reasonable we are with our licensees.

John Ballot.

Q. 2. Read the list now.

A. "Inspiration Consolidated Copper Company; M. W. Atwater, Consolidated Arizona Smelting Company, Wm. B. McDonald and Louis S. Noble, Atlas Mining & Milling Co., The Elm Orlu Mining Co., Old Dominion Mining and Smelting Co., Weedon Mining Company, Mountain Copper Company, Limited, Engels Copper Mining Company, St. Joseph Lead Company, Anaconda Copper Mining Company, Cananea Consolidated Copper Company, Arizona Copper Company, Limited, Arizona Copper Company, of Arizona, Doe Run Lead Company, Desloge Consolidated Lead Company, Utah Leasing Company, Napoleon Mining Company, Chichagoff Mining Company, Colusa Parrot Mining & Smelting Company, Dutch Sweeney Mining Company, Portland Gold Mining Company, Stoddard Milling Company, Butte Central Mining & Milling Company, Goldfield Consolidated Mines Company, Reward Gold Mining Company, Ely Associated Brockman & Company, Ceylon Company, Ducktown Sulphur, Copper & Iron Company, Phelps Dodge & Company, Pigrey Mines, Vindicator Consolidated Gold Mining Company, Broadwater Mills Company, Britannia Mining & Smelting Company, Mond Nickel Company, Limited, Cuba Copper Company, Silverton Mines, Flint Mines, Limited, Mineral Recovery Company, Standard Silver Lead Mining Co., Cusi Mining Company, Highland Valley Mining & Development Co.; and in South America, Braden Mines in Chili.

John Ballot.

MR. WILLIAMS: I regret to find that my very valuable assistant has not brought the original licenses into court at the present moment but they will be produced later.

MR. KREMER: That is all right.

MR. WILLIAMS: I now produce an affidavit by Henry Falck, the general office manager for Beer, Sondheimer & Company, Inc., the American agents for Minerals Separation Limited, plaintiff. It has been stipulated between counsel that this affidavit shall be received in evidence with the same force and effect as though Mr. Falck were brought here from New York and testified as to the facts stated in the affidavit; and a table of returns and payments of royalties by United States licensees of Minerals Separation Limited, which is annexed to the affidavit.

MR. KREMER: This stipulation, Mr. Williams, is, of course, subject to the objection that it is incompetent irrelevant and immaterial for any purpose in the case. We do not object to the fact that Mr. Falck is not present.

THE COURT: It is not incompetent, that is, as to form.

MR. KREMER: Not as to form. Our stipulation goes to the matter of form. Incompetent as to the matter of substance. It makes the trip of a man from New York unnecessary.

THE COURT: The objection will be overruled.

MR. KREMER: Exception.

MR. WILLIAMS: The affidavit and annexed table are offered in evidence.

MR. KREMER: The defendant objects for the reason that as to substance the affidavit and the exhibits there attached is incompetent, irrelevant and immaterial for any purpose in the case.

THE COURT: As far as the receipts are concerned I doubt if it would be of very much materiality, but it will be allowed to be introduced over the objection. The objection will be overruled.

MR. KREMER: Exception.

Whereupon affidavit was admitted in evidence MARKED PLAINTIFF'S EXHIBIT 236.

Q. 3. MR. WILLIAMS: I show you the table of returns and payments of royalty annexed to Mr. Falck's affidavit and call your attention to the fact that in the column, "Tonnage Material Treated" there are several items marked "Not reported." Will you explain why these items are not reported, or were not reported?

A. The tonnage of ore treated, because this was to be paid in percentages on metals recovered.

Q. 4. And on the other hand, in the column headed, "Tonnage of concentrates Recovered" there are several items marked "Not reported." Why are those items not reported?

A. Why, they paid on the tonnage of straight ore treated. We were not concerned with the concentrates.

John Ballot.

Q. 5. That is to say, as I understand it, if the license provided that royalty should be paid upon the ore treated, then the return shows the tonnage of ore treated?

A. Yes, sir.

Q. 6. And if the license provides that the payments shall be made upon concentrates recovered, then the returns show the concentrates recovered?

A. That is correct.

Q. 7. So that the table does not give entirely the total of ore treated by the licensees or the total of concentrates recovered by the licensees?

A. That is correct.

Q. 8. The only total given in the table is under the heading of amount, which of course is the royalties, and there the amount is $1,155,258.24. That is the total royalties received is it not?

A. That is correct.

Q. 9. From the licensees in the United States of America?

A. In the United States of America.

Q. 10. And as to the other licensees in America, whose names you have given, those in Canada, Cuba and South America, there is no reference whatsoever to their payments in this table?

A. That is correct.

John Ballot.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 11. Mr. Ballot, are these sums paid to Minerals Separation as shown in the list you exhibited, paid exclusively for the right to operate under the patent here involved in this suit, No. 835120, or are there other patents?

A. There are other patents. All the licensees are entitled to use all or any patent.

X-Q. 12. And some twenty or more other patents, are there not?

A. More than twenty.

X-Q. 13. Among those patents is there included what is generally referred to as the Potter patent, and a Delprat patent?

A. In some of them; not all.

X-Q. 14. Are these processes described in the Potter patent and the Delprat patent being used?

A. I don't know; I haven't heard of it.

X-Q. 15. Have they ever been used?

A. By American licensees?

X-Q. 16. Yes.

A. Not that I know of.

X-Q. 17. By anyone?

A. Not that I know of.

MR. WILIAMS: I object to the inquiry which is intended to cover the whole breadth of the earth, as I understand it, as indefinite.

John Ballot.

THE COURT: He has answered it.

X-Q. 18. MR. SCOTT: You mean to state distinctly that you do not know that anyone anywhere ever made use of the Potter process and the Delprat process?

MR. WILLIAMS: I object to any inquiry of this character as wholly irrelevant and immaterial and not within the scope of the direct examination of the witness; wholly immaterial and irrelevant.

MR. SCOTT: The alleged evidence of acquiescence has included reference to companies outside of the United States, Canada and Chili, and it is my purpose to develop to what extent these licensees have any connection with the patent here in suit and to what extent they may be paying for others of the privileges granted for these licenses herein, and it seems to be entirely proper, when we have figures brought here representing payments of money calculated, or at least deemed by the plaintiff to show the alleged importance of its patents—

THE COURT: Well, do we understand that applies also on the Delprat and Potter?

MR. SCOTT: I think Mr. Ballot said they were included in these lessee agreements.

THE WITNESS: Some of them.

MR. SCOTT: And I think it is my purpose to show that these have been used exclusively, have never been supplemented in some localities, and there is no reason to infer that these figures which have been presented before the court are due entirely, or are due

in a large degree to the particular patent that is now before the court.

MR. WILLIAMS: These facts are limited to the United States.

THE COURT: The facts are such that there is other testimony, covering other countries. I think it is proper cross examination. He may answer. Objection overruled.

Exception by plaintiff.

THE COURT: It will be noted.

X-Q. 19. (Question read as follows) "Q. You mean to state distinctly that you do not know that anyone, anywhere ever made use of the Potter process and the Delprat process?"

THE COURT: I think I will limit it to their licensees. You asked him "anyone". You may change the question. So far as the question is objected to in that form ,the court will sustain the objection. It should be limited to the licensees.

X-Q. 20. MR. SCOTT: Do you mean to state distinctly that none of the licensees of Minerals Separation, Limited, have ever made use of the Potter process or the Delprat process?

A. I never heard of that. I don't know.

X-Q. 21. Has Minerals Separation, Limited, licensees, either directly or indirectly through subordinate companies, in countries other than the United States?

A. Through subsidiary companies.

X-Q. 22. And in what countries does Minerals

John Ballot.

Separation Limited grant licenses through subsidiary corporations?

A. Minerals Separation has only granted licenses in America, including United States, Canada, Mexico and Cuba.

X-Q. 23. Minerals Separation, Limited, has no connections in Australia?

A. Indirectly as shareholders in a company owning the processes there.

X-Q. 24. And either directly or indirectly has Minerals Separation, Limited, any licensees in Australia?

A. Directly, yes; indirectly, no. Directly, yes, licenses were issued while Australia belonged to Minerals Separation. These licenses have simply remained in the same name and passed, after transfer, over to the purchasing company when they acquired the Australian rights. And no, since then we have no direct connection.

X-Q. 25. And who were these licensees; who are licensees direct from Minerals Separation Limited?

A. In Australia?

X-Q. 26. In Australia.

A. Before the—

X-Q. 27. Before the arrangement you just spoke of.

A. The Sulphide Corporation, the Zinc Corporation,—some minor companies I don't recall.

X-Q. 28. Did either the Sulphide Corporation or the Zinc Corporation ever use the Potter process or the Delprat process?

A. Not that I know of.

John Ballot.

X-Q. 29. Now, what is the arrangement at present for the granting of licenses in Australia?

A. The Australian company grants them directly.

X-Q. 30. And do any of the licensees of the Australian company use the Potter process or the Delprat?

A. Not that I know of.

X-Q. 31. What is the extent of your information about what these licensees are doing?

A. I have no direct information.

X-Q. 32. You are in a state of complete ignorance as to what these licensees are doing after they get their licenses?

A. We don't bother our licensees.

X-Q. 33. Do you know what these licensees in the United States are doing; what processes they are practising, whether it is one or the other of these 20 or 30 processes that you grant the licenses under?

A. I have a general idea; I can't say that I have definite information.

X-Q. 34. Might be the Kirby process for all you know, or the Froment process or the Glogner process or any of these prior art processes for all you know; is that the idea?

MR. WILLIAMS: Why, if your honor please, there has not been a word of proof that these things that are described in these patents were processes of the prior art, and they are put to this witness as though they had some tangible existence, other than on sheets of paper. I object to the form of the question.

John Ballot.

(Question read as follows: "Q. Might be the Kirby process for all you know, or the Froment process or the Glogner process or any of these prior art processes for all you know; is that the idea?")

THE COURT: What is your objection?

MR. WILLIAMS: My objection is that the thing that the defendant calls "processes" are things that exist only on pieces of paper. They have no definite standing in the art of concentrating ores; and to present them to the witness as processes of the art is to misrepresent the evidence that the defendant has brought to this court.

MR. SCOTT: Some of these patents I have mentioned are the ones you grant licenses under. You include them in your definition of prior art.

MR. WILLIAMS: Some of them are mere paper patents.

THE COURT: The difficulty is that I think the witness has answered that their licensees, or these licensees are entitled to use all such patents, some 20 or more. Now, he is trying to weed out and find how many of these are operating under the patent in suit, which of course is all that is material here, and how many of these licensees may be operating under some other patent.

MR. WILLIAMS: Yes, but the statement he has put in his question, the patents he has referred to are not patents that are in the list.

THE COURT: There is the difficulty. The court does not know.

John Ballot.

MR. WILLIAMS: We haven't the schedule here.

THE COURT: The court does not know. It is for you to show. Unless these are patents that are a part of the licenses, it is immaterial.

MR. SCOTT: He has not produced it and I can not tell which are, but I will withdraw the question to avoid the difficulty.

X-Q. 35. Now, Mr. Ballot, you claim to have no knowledge of what processes your licensees or your licensees through subsidiaries are practicing in Australia. Have you any definite knowledge of what they are practicing in this country?

A. I have no personal knowledge of what they use.

X-Q. 36. When did Phelps, Dodge & Company become a licensee of Minerals Separation; about what was the date when they became licensees?

A. That is a matter of memory; I think it was 1913.

MR. WILLIAMS: May I help the witness.

MR. SCOTT: You can give the date.

MR. WILLIAMS: The date of that license as given by a list prepared is June 11th, 1914.

THE WITNESS: 1914, I believe that is correct.

X-Q. 37. I think, Mr. Ballot, that the name Phelps, Dodge & Company does not appear in the list of royalty payments which you produced; is that correct?

A. I believe that is correct.

X-Q. 38. And can you explain why that is?

A. Because they have not paid.

John Ballot.

X-Q. 39. Have they milled any ore under any one of these twenty or thirty patents that they had the license under?

A. I don't know from personal knowledge; they have not made a return.

X-Q. 40. How do you proceed to find out whether these licensees owe you any money or not, if you don't know whether they are practicing one of your twenty or thirty processes, or not?

A. The licensees are asked every quarter to make returns.

X-Q. 41. Did you ask—do you ask Phelps, Dodge & Company, for a return?

A. Possibly; I cannot tell you from personal knowledge. It is an office routine; I cannot tell you.

X-Q. 42. Do you know any reason why they have not made any payments to you?

A. No.

X-Q. 43. Have you ever tried to find out why that is?

A. I expect the office has found out.

X-Q. 44. Well, does their license provide that they—how does it provide that they shall pay you any money?

A. Well, if they are honest people they ought to send in returns quarterly when they treat.

X-Q. 45. Were you ever in Australia?

A. No, sir.

X-Q. 46. Are there any others of these licensees upon that list who have never paid you any license fees?

John Ballot.

A. I find the Old Dominion Mining & Smelting Company, yes.

X-Q. 47. Have you named all those that have made no payments?

A. I recognize the Old Dominion Mining & Smelting Company.

X-Q. 48. Any others?

A. There are some, but I cannot answer in person.

X-Q. 49. Is it not true that none of these people have made any payments, except those whose names appear on the statement accompanying Mr. Falk's affidavit?

A. The licensees in the United States—possibly.

X-Q. 50. Well, in the United States has any company or individual paid license fees other than those upon the list accompanying Mr. Falck's affidavit?

A. I don't think so.

X-Q. 51. How many licenses did Minerals Separation, Limited, have in the United States, in October, 1911?

A. I couldn't tell you that from memory.

X-Q. 52. You know they didn't have any, don't you?

A. October, 1911?

X-Q. 53. October, 1911?

A. Possibly not; possibly not.

X-Q. 54. What is your position in Minerals Separation, Limited?

A. Chairman and managing director.

John Ballot.

X-Q. 55. Don't you, as chairman and managing director, know whether or not Minerals Separation, Limited, had a licensee in the United States in October, 1911?

A. I do.

X-Q. 56. And they did not have any, did they?

A. Possibly not. I could verify it, but from memory I cannot.

X-Q. 57. Well, I wish you would verify it. Isn't it a fact that the first license that was ever granted by Minerals Separation Company to anyone in the United States was that to the Inspiration Copper Company on April 10th, 1913?

A. It is one of the earliest, if not the earliest.

X-Q. 58. Can you state positively whether it is the earliest or not by referring to this paper from which you refreshed your memory?

A. If this list represents the full list of licensees, it is the first; it is the first on the list.

X-Q. 59. Do these reports which you get from these licensees show anything about what kind of a process they are operating, whether it is one or the other of these many patents?

A. No.

X-Q. 60. Who has all this information about what these licensees are doing?

A. I expect they have their own reports—their own records. We don't keep them.

X-Q. 61. No one in your company has any knowledge of how they are operating?

A. Our engineering staff—our technical staff visit them and check them up.

X-Q. 62. And your license agreements provide that you shall have access and full information about these licensees, what they are doing?

A. Yes, I think so.

X-Q. 63. And still you have never acquired any of that information whatever?

A. I personally, or the company?

(WITNESS EXCUSED).

IRA L. GRENINGER, called as a witness in behalf of the plaintiff, being first duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. WILLIAMS:

Q. 1. State your full name and occupation?

A. My name is Ira L. Greninger; my occupation is that of mining engineer and metallurgist.

Q. 2. Where are you at present employed?

A. I am employed by the Inspiration Consolidated Copper Company at Miami, Arizona.

Q. 3. And what is your position with that company?

A. Acting mine superintendent at present.

Q. 4. And how many men have you under you in your position as mine superintendent?

A. Something over a thousand.

Q. 5. And about how much ore is mined per day in that mine?

A. From nineteen to twenty-one thousand tons.

Q. 6. Prior to your employment as superintendent of mines, what was your employment?

A. I was employed by Minerals Separation, American Syndicate, Ltd., 1913, to give the full title.

Q. 7. What work did you do for them?

A. I was engaged in demonstrating the flotation process and installing plants in various parts of Canada and the United States.

Q. 8. When did you commence to work on flotation?

A. In the month of July, 1911.

Q. 9. And what did you do in reference to the installation in Canada for the Brittania Mining & Smelting Company?

A. I installed a small test unit at the mill of the Brittania Mining & Consolidated Company, now the Howe Sound Company.

Q. 10. When?

A. In the month of June, 1912, as I remember.

Q. 11. And what kind of ore did you treat in that plant?

A. Their ore is a copper bearing ore, the mineral being in the form of chalcopyrite.

Q. 12. And of what richness in copper?

A. At that time about four and a half to five per cent.

Ira L. Greininger.

Q. 13. And in this plant that you installed—in the first place what sort of plant was it?

A. It was a standard Minerals Separation plant of fifty tons capacity?

Q. 14. And what frothing agents did you use in the operations with that ore?

A. Well, I experimented with quite a number of different frothing agents, but I finally came to the use of a wood tar oil known as Stockholm tar, mixed with certain mineral oils.

Q. 15. Did you use acids?

A. I did not.

Q. 16. Or heat?

A. No, I didn't use any heat.

Q. 17. And in what proportion did you use this mixture of Stockholm tar and mineral oil?

A. The average was about two pounds per ton of ore treated.

Q. 18. And what recoveries were made?

A. The recoveries after the experimental stage had passed, were very good, being from 88 up to 95 per cent, and as high 97 per cent at times.

Q. 19. And as to the grade of concentrate that you obtained?

A. The grade was about 20 per cent on an average in copper.

Q. 20. How long did you stay at this plant in connection with this first installation?

A. I remained at the plant until the month of November of the same year, 1912.

Ira L. Greininger.

Q. 21. Did you visit the plant again at a later time?

A. Yes, I visited the plant once in 1913, in the month of July.

Q. 22. And what did you find installed at the plant in the way of flotation when you again visited it?

A. They at that time had in operation a 600 ton standard Minerals Separation plant.

Q. 23. And what frothing agents were being used with that plant at that time?

A. They were using the same mixture that I had left with them at the time I left the plant.

Q. 24. And as to the grade and recoveries, what was the condition?

A. The recoveries in the larger plant were somewhat better than in the smaller plant at this time that I was there and had access to the assays.

Q. 25. And was there or was there not any reorganization of other parts of the mill that had taken place?

A. There was.

Q. 26. What was it?

A. Originally the mill consisted of coarse jigs, fine jigs, tables, and vanners, preceded by hand-sorting. After the installation of the large flotation machine they discontinued the hand sorting and the coarse jigs, the tables and the vanners, using their fine jigs. The jig tailings were reground and treated by flotation.

Ira L. Greininger.

Q. 27. Did you have anything to do with the installation of flotation at the Inspiration Consolidated Copper Company, where you are now employed?

A. I did.

Q. 28. When did that commence, and what did you first do there?

A. I installed a 50 ton standard Minerals Separation unit for the Inspiration Company in January, 1913, in the fore part of the month.

Q. 29. And how long did you continue there with that installation?

A. With that particular plant I continued until June of that year.

Q. 30. So it was run for six months?

A. About six months, yes.

Q. 31. That was regarded as what sort of an operation?

A. Experimental purely.

Q. 32. For the purpose of demonstrating the usefulness of the process on that ore?

A. Yes.

Q. 33. Were the operations of a satisfactory nature?

A. They were.

Q. 34. What grade of concentrate and what recovery were obtained in those operations when they got down to what was regarded as the better conditions?

A. We usually based our figures on the extrac-

Ira L. Greininger.

tions of the sulphide content of the ore, due to the fact that in the ore, at the Inspiration—part of the mineral in it is oxidized in form and is not readily recovered either by flotation or gravity methods, and as to this amount of oxidized ore, the proportion changes in different parts of the mine, our figures are based largely on the recovery of sulphide material, and in the recovery of that material our figures ran from around 88 to well above 90 per cent. Our grade of concentrate varied from 25 to 54 per cent in copper.

Q. 35. What frothing agent was used; what finally was decided upon as the best thing to use?

A. After experimenting with several oils we concluded that cresylic acid was the best, and therefore we used that agent largely, almost exclusively, in the plant.

Q. 36. In what form did you use it, a crude or a pure product?

A. Crude cresylic acid.

Q. 37. You might state whether or not this crude product contained some other material than cresylic acid?

A. Well, I never analyzed it, or never had it analyzed, but from its appearance I should say it did, because it has not the appearance of pure cre~~osote~~sol, being dark in color.

Q. 38. Cresylic acid is the commercial name for cresol?

Ira L. Greininger.

A. That is what I understand.

Q. 39. Did you use anything else as a frothing agent or as a reagent in that operation, than cresylic acid?

A. We experimented with various oils, but did not find any of them as satisfactory as cresylic acid at that time.

Q. 40. Did you decide upon the relationship between the water concentration and flotation as the result of that work?

A. Well, we simply submitted our results to the management of the Inspiration at that time, and they decided.

Q. 41. Well, what did you decide?

A. We tested the relationship of water concentration to flotation.

Q. 42. And what was finally decided upon as the next operation by the management?

A. They decided to install a larger experimental unit, thinking this one was somewhat too small upon which to base their large scale plans.

Q. 43. And did you attend to that installation?

A. I did.

Q. 44. And when was that done?

A. That was in the following year, January of 1914.

Q. 45. And how large a plant was that?

A. That was a standard 600 ton Minerals Separation unit.

Ira L. Greininger.

Q. 46. And how long was that standard 600 ton unit operated?

A. That unit, or one that was installed afterwards, was operated up to the time that I resigned from the employ of Minerals Separation, ~~Limited,~~ American Syndicate, 1913 Limited; in August, 1915.

Q. 47. That whole operation, was it within the finished mill or outside of the mill that was being built?

A. It was outside of what is now the mill, in a temporary building.

Q. 48. And what is the present flotation installation of the Inspiration Consolidated Copper Company?

A. The kind of machines you refer to?

Q. 40. Well, in the first place their number?

A. They are using three separate sorts of machines.

Q. 50. The number of machines and their style?

A. There are at the present time in operation 19 sections in the mill, four of which are equipped with Callow cells, and one section is equipped with what we refer to as the Hebbard type of Minerals Separation machine. The other sections are equipped with what is known as the Inspiration type of machine.

Q. 51. That latter being a type developed by the Inspiration Company?

A. Developed by the Inspiration Company at that point, in their mill.

Q. 52. How near is the flotation plant to completion; you say there are 19 sections running?

A. Well, as originally planned, the mill consisted

Ira L. Greininger.

of 18 sections, and that has been in operation now for over a year, but later they decided to increase the capacity of the mill by two sections, one of which has been put in commission, but the twentieth is not yet in commission—or was not at the time I left Arizona.

Q. 53. What is the capacity, or what is the amount of material that is being treated by these 19 sections that are now at work?

A. The average is above 18,000 tons per day. The highest figure that I recall now is 19,600 or thereabouts, for one day in April, before I left the plant.

Q. 54. The feed, whatever it may be—19,600 tons?

A. Well, I wish to correct that. It should be 18,600 instead of 19,600.

Q. 55. This feed of 18,600 tons or 18,000 tons, is divided in what manner between these 19 flotation sections?

A. Each flotation section gets it as fed direct from a storage bin, from which it passes to the grinding mills which are independent for each section, each being a unit in itself. One has no connection with another.

Q. 56. That is, each section receives one nineteenth of the feed approximately? Is that right?

A. Theoretically yes, that is the way it is intended.

Q. 57. And the feed that is divided into 19 different parts, we will follow in one of the sections. What does the feed enter after it has been divided?

WHEREUPON an adjournment was taken until 2:00 p. m. May 7th, 1917.

Ira L. Greininger.

Monday, May 7th, 1917, 2:00 p. m.

A. In each section it enters one of two ball mills; the feed is again divided, the ball mills working in parallel—ball mills of the Marcy type. Each ball mill is operated in closed circuit, with a Dorr classifier. The oversize is returned to the ball mill, and the under size goes direct to flotation. The oil in the meantime has been added at the intake of the ball mills. Taking a section equipped with Callow flotation machines, for instance, the pulp is conducted to the rougher cells, which may be eight, twelve or sixteen in number; there is a different number in the various sections. These produce a rougher concentrate. The tailings from these cells are classified in a Drag or Esperanza classifier, the slimes being returned for further treatment in another set of Callow cells, and the sands going to the hydraulic classifiers, and thence to tables. The product of the primary roughers, as well as the product of the roughers treating the return slime, are retreated in a set of recleaning cells, four in number for each section.

Q. 58. Now, at the head of the flotation section you say there are two ball mills?

A. Two ball mills.

Q. 59. And the oil is added at the head of the ball mills?

A. It is.

Q. 60. What happens as the pulp flows through these ball mills with the oil in the pulp?

A. The oil is thoroughly mixed, and the whole receives quite a violent agitation.

Q. 61. Is there any name for that method of grinding the pulp in the presence of the oil?

A. It is usually referred to as modifying during grinding, or as preagitation.

Q. 62. And that is true of all the sections, is it, that there is modifying during the grinding?

A. In all the sections, yes.

Q. 63. Now, in the sections containing the Inspiration flotation machine the pulp passes directly from the grinding mills to the machine?

A. It does, to the rougher machines.

Q. 64. Give a general description of that Inspiration rougher machine?

A. The Inspiration machine may be characterized as a large launder; it is about 48 feet long by I think about eight feet six inches in width, divided into two units in the center, that is, each section of 24 feet comprises a separate unit, although operated in series. It is about four feet in depth, and is provided with a porous bottom under which air under pressure is introduced.

Q. 65. That porous bottom is made of what material?

A. Of canvas.

Q. 66. Several layers?

A. Yes, a thick layer of canvas.

Q. 67. And compressed air is supplied underneath, and what does the compressed air do?

Ira L. Greininger.

A. It acts the same as in the Callow machine; it agitates and aerates the mixture. The pulp flows into the ball mills from a launder provided for the purpose. The concentrate from the rougher machine is passed to a cleaner of the same type, but somewhat smaller than the roughers. The tails from the rougher machine are classified in a Drag or Esperanza classifier, ~~the slimes~~,—the slimes being sent to waste, and the sands given further treatment by tables.

Q. 68. Now, that section containing the Minerals Separation-Hebbard type machine, does the pulp flow directly from the grinding mill to the flotation machine?

A. It does.

Q. 69. In the flotation machine are there revolving agitators?

A. Yes. These particular machines were equipped with ten revolving agitators.

Q. 70. Give a general description of the machine.

A. It is made up of a very long, rectangular box provided with ten agitators, each agitator occupying one-tenth of the length of the box, and above these agitators are arranged a series of iron or steel baffles extending about a foot above the agitators. There are eight projections or baffles around each agitator, eight separate baffles.

Q. 71. And the function of these baffles in these machines?

A. Is to produce a more quiet condition of the water above the baffles than would be possible if the baffles were not there.

Ira L. Greininger.

Q. 72. Is air supplied, and if so, how supplied?

A. Air is supplied underneath each impeller or agitator, under pressure from the same system that supplies the Callow machine and the Inspirator machine.

Q. 73. Does this flow through a porous medium?

A. It does not.

Q. 74. Just flows through a pipe?

A. Forced in through a pipe and is broken up in fine bits by the action of the agitator.

Q. 75. That is to say, the agitator performs the function of producing the small air bubbles?

A. Yes.

Q. 76. And you have described one machine. Is this a rougher machine?

A. That is the rougher machine. There are two cleaners provided, both of the same type, excepting they are provided with six agitators instead of ten.

Q. 77. Are they in series or in parallel?

A. They run in parallel when they are both operating.

Q. 78. So that the overflow is divided between the two cleaners?

A. Yes.

Q. 79. And these cleaners produce what kind of a concentrate?

A. They produce the finished concentrate. The tails from the cleaners are passed to the roughers and the tails from the roughers go to the usual classifier arrangement, the slimes being discarded, and the sands treated on the tables.

Ira L. Greininger.

Q. 80. And what becomes of the sands from all of these sections of this flotation section?

A. They are all passed over tables.

Q. 81. Passed over shaking tables?

A. Passed over shaking tables made by the Deister Machine Company.

Q. 82. So that in this plant we have all of the shaking table treatment below the flotation?

A. All following flotation.

Q. 83. Was that the result of the tests that you made as to which was the better way of treating it?

A. That was the final decision arrived at on the basis of the tests made.

Q. 84. Now, what kind of an ore is the Inspiration ore?

A. It is a copper bearing ore, the copper being principally in the form of a chalcocite.

Q. 85. And about what proportion of copper is present in the ore?

A. During 1916 the average was about 1.54% copper.

Q. 86. Now, your knowledge of the operations in the flotation plant was carried up to about what time?

A. The latter part of 1915.

Q. 87. What frothing agent was being used in the plant at that time?

A. We were using crude coal tar and cresol oil at that time.

Q. 88. In what proportions?

A. A pound and a half per ton, or less.

Ira L. Greininger.

Q. 89. May I ask you if you mean a pound and a half or less per ton of ore?

A. That is what I mean, yes; per ton of ore treated.

Q. 90. In your experience at the Inspiration flotation plant was there any occasion, when the amount or proportion of oil was increased beyond the normal proportion? If so please relate the circumstance or circumstances.

A. Yes, there were several occasions of that kind.

Q. 91. Well, you may take them up as they occur to your mind.

A. The first instance occurred in the early part of the experimental work in 1914, possibly in April. There was a condition which myself and my operators had observed for several days when the froth appeared to be overoiled and the tables following flotation would suddenly become covered with incipient granules, showing that the flotation plant was not performing its function; and the levels of the different compartments of the flotation machine were hard to maintain. I had formed the opinion that this was caused by leakage from a machine, a grinding machine we were using at that time which was known as the Symonds Disc machine, which had a large oil reservoir in its base. In order to test out my theory I took some of the oil that was used in this disc machine as a lubricant and added it to the flotation machine.

Q. 92. In what proportion?

A. At a proportion which I calculated at about 5 pounds per ton.

Ira L. Greininger.

Q. 93. The normal food was how much?

A. One and a half to 1.6 per ton.

Q. 94. So the total then was increased to about six and a half?

A. Something over six pounds. This brought about the same condition we had observed previously, wihch confirmed my opinion as to what was the cause of our trouble.

Q. 95. Was there another occasion of that kind that you recall?

A. Yes, there was another occasion the following year when I added pine oil to the pulp in addition to the regular oil that was being used at that time.

Q. 96. Did you do that intentionally?

A. I did it intentionally, that is, for a purpose of my own, not knowing the effect it would have on the flotation plant.

Q. 97. What was the purpose?

A. The purpose was to dissolve some accumulated tar in a feed pipe which carried the tar into the various grinding mills.

Q. 98. And what was the result?

A. The result was that concentration practically ceased in the flotation plant and there was a great volume of froth produced, but it was very low in grade; in fact, it wasn't much higher grade than the original ore, from inspection.

Q. 99. And how much of this pine oil did you add at that time?

A. Well, as near as I can recollect it amounted to

Ira L. Greininger.

about two pounds per ton, during the time it was going in.

Q. 100. And what was the normal feed of oil then?

A. About the same that it was previously as I have testified to, about 1.5 to 1.6 pounds per ton.

Q. 101. Making the total feed about what?

A. About 3½ lbs. per ton.

Q. 102. Now, did you do anything in connection with a flotation plant at the Atlas Mining & Milling Co., and if so when?

A. A flotation plant of 150 tons daily capacity was installed at the Atlas mine near Ouray Colorado, in the fall of 1913.

Q. 103. What kind of ore was there treated?

A. It was a lead-silver bearing ore.

Q. 104. And about what contents?

A. About 2% of lead and from 10 to 14 ounces of silver as I remember it.

Q. 105. What frothing agents were used in that plant?

A. After the experimental stage, crude carbolic acid was the principal frothing agent used.

Q. 106. in what proportion?

A. A pound to a pound and a half per ton.

Q. 107. Between a pound and a pound and a half of carbolic acid?

A. To the ton of ore treated.

Q. 108. And what recoveries were obtained?

A. The recoveries were about 90% of the lead and

Ira L. Greininger.

80 to 85% of the silver at the time I was last at the plant.

Q. 109. And what was the grade of the concentrate obtained?

A. About 20 per cent lead and up as high as a hundred ounces of silver per ton of concentrate.

Q. 110. Now, in all of these operations that you have described, in what manner was the concentrate recovered?

A. In the form of a froth.

CROSS EXAMINATION.

BY MR. SCOTT:

X-Q. 111. You have charge of the flotation operations now at the Inspiration mill, have you?

A. No, not at the present time.

X-Q. 112. What was your first experience with flotation?

A. My first experience with flotation was in the laboratories of the Minerals Separation American Syndicate.

X-Q. 113. When was that, in 1911?

A. Starting in 1911.

X-Q. 114. In July, 1911?

A. Yes.

X-Q. 115. What oils did you use in your first experimental work?

A. Oh, we used a large number of oils, all of which I could not remember. We used cresylic acid and Stockholm tar and various mineral oils, fuel oils.

Ira L. Greininger.

X-Q. 116. In actual operations what oils have you found to be used, as far as you can recall them to memory.

A. I have used wood tars, and cresylic acid and various creosote oils, and crude coal tar and other products of coal tar, and pine oils; I think that would about cover the classes.

X-Q. 117. What mineral oils?

A. I have used fuel oil, and a lighter distillate from fuel oil at times, or attempted to use them.

X-Q. 118. What is fuel oil?

A. As we understand it in the west it is the residuum after the lighter ingredients have been distilled off from petroleum, such as kerosene and gasolene.

X-Q. 119. Did you use fuel oil in any of the plants you have been connected with?

A. I have never found it useful in itself, and only once have I used it, after having experimented. I experimented with it and only once have I used it as a steady ingredient of the mixture, and that was at the Britannia Company, ~~which was~~—which is now the Howe Sound Company, British Columbia.

X-Q. 120. And they use it as a steady thing?

A. A portion of the ~~mixture~~, about 25 per cent is made up of it.

X-Q. 121. What was the rest?

A. 25 per cent tar and 50 per cent of distillate of fuel oil.

X-Q. 122. So 75 per cent of the mixture was derived from petroleum?

Ira L. Greininger.

A. Yes.

X-Q. 123. And the other 25 per cent was what?

A. Wood tar oil.

X-Q. 124. What was the first working plant that you had experience in?

A. This plant we have just been referring to, the Howe Sound Company at Britannia Beach, British Columbia.

X-Q. 125. When did you go there?

A. 1912.

X-Q. 126. What month?

A. I went there in May, and I installed the plant there in June.

X-Q. 127. What was going on there when you got there in the way of flotation?

A. Nothing at that time.

X-Q. 128. You went there to introduce it?

A. Yes.

X-Q. 129. What did you do first?

A. I set up my plant and went to work on the flotation of ores.

X-Q.130. What sort of a plant was it?

A. A standard Minerals Separation plant, fifty tons capacity.

X-Q. 131. What is the standard plant like, describe it?

A. This plant was made up of eight agitating compartments and eight spitzkastens, the pulp passing from the first agitation department to the spitzkasten and then back to the next or succeeding agitating depart-

ment and so on through the plant. Later I cut out—

X-Q. 132. Carried there by gravity?

A. No, it carried by the action of the impellers.

X-Q. 133. The spitzkasten projected down below the agitating cell?

A. Yes.

X-Q. 134. And you had a pipe leading from the spitzkasten to the next cell, and the pulp was drawn up by the action of the agitators or impellers?

A. That is right.

X-Q. 135. Was that all there was to this machine?

A. That is all, yes.

X-Q. 136. How did it work when you first started it?

A. It worked beautifully.

X-Q. 137. What oil did you use?

A. I think I was using turpentine to start with.

X-Q. 138. What is turpentine made from?

A. It ~~was~~ made from destructive distillation of Douglas fir wood.

X-Q. 139. It is made about the same way as pine oil, isn't it?

A. Well, I am not an authority on that subject; I suppose it is, but I don't know.

X-Q. 140. What kind of recovery did you make when you first started up this plant?

A. Oh, our recoveries were very high, probably above ninety per cent; 90 to 95 right from the start, while we were working on the particular products that we started on.

Ira L. Greininger.

X-Q. 141. What kind of product did you get?

A. We got a concentrate which assayed from 20 to as high as 29 per cent copper.

X-Q. 142. How soon after you first started up your machine did you get such a concentrate and recovery as that?

A. About two hours.

X-Q. 143. Where did you go next?

A. I went to the home office, and then to the Inspiration Mine.

X-Q. 144. Had you experimented with these Britannia ores any in the laboratory before you went there?

A. I had not.

X-Q. 145. Did anybody to your knowledge?

A. I think some others had, yes.

X-Q. 146. And you had their results, I suppose?

A. I had their results.

X-Q. 147. And their recommendations of how to treat the ore?

A. Well, it did not really avail us anything because we were not able to get the oils that we had used in the experimental laboratory; we had to pick up what local oils we could find.

X-Q. 148. Do you know how long an investigation had been made of these Britannia ores which you refer to?

A. The investigation could not have covered more than a week or two, because I have a recollection of the time that the samples were shipped, and it appears to

me that it was not more than at the outside two weeks before I went to the Britannia.

X-Q. 149. Do you know of any other samples that were shipped before the ones that you knew of?

A. I have not any personal knowledge. I think there were, however, some crude ore samples which were shipped before that time, but that was not the product that I was treating.

X-Q. 150. What were you treating?

A. I was treating a lot of accumulated slimes that had not been found capable of treatment by any other process that they had.

X-Q. 151. How much did you treat at the Inspiration?

A. It was a 50-ton plant, like the Britannia.

X-Q. 152. Was there any flotation there when you went there?

A. No.

X-Q. 153. Your plant was the first?

A. Yes.

X-Q. 154. That was January, 1914?

A. 1913.

X-Q. 155. How long did you experiment with that first plant?

A. Until June of that year.

X-Q. 156. What were you doing during that time?

A. Well, for the first month we were experimenting with the various oils, and getting good, bad and indifferent results.

X-Q. 157. What kind of oils did you experiment with?

Ira L. Greininger.

A. We used cresylic acid, and various wood tar oils, and some pine oil and some creosote oil from the Barrett company.

X-Q. 158. Any mineral oils?

A. We attempted to use mineral oils, but found them useless.

X-Q. 159. What oil did you finally decide on?

A. We finally decided on crude cresol or cresylic acid.

X-Q. 160. What kind of results did you get the first month?

A. Well, they were very erratic; they were good at times, and other times not so good.

X-Q. 161. What made them erratic, did you find out?

A. I think experimenting with the oils principally.

X-Q. 162. Getting the right oil?

A. That I think was largely the trouble.

X-Q. 163. Did you alter the machine or its mode of operation during that six months?

A. We altered the flow as to the number of spitzkastens carrying middlings, and we also used tables before the flotation plant and tables following the flotation plant at various times, but the flotation plant itself was never altered.

X-Q. 164. Do you remember the first oil you used at Inspiration?

A. No, I could not say what the first oil was.

X-Q. 165. What oils were they that gave bad results?

Ira L. Greininger.

A. Well, it is easier to classify them as to the ones that give good results.

X-Q. 166. That gave bad results I asked you?

A. Well, the wood tar oils were found impossible of use. Pine oil was useful to a limited extent. The creosote oil was of no use whatever—the creosote oil that we had at that time.

X-Q. 167. Can you tell me what mixtures you finally decided on at that time?

A. It was no mixture; it was a straight crude cresol.

X-Q. 168. And that is the oil they use now?

A. No, they are not using that now and have not for a long time.

X-Q. 169. What are they using now?

A. Principally crude coal tar.

X-Q. 170. How much carbonate of copper is in that Inspiration ore?

A. It varies greatly. During 1916 it averaged about .35 of one per cent I think.

X-Q. 171. Did the flotation recover much of that?

A. Very little.

X-Q. 172. Negligible is it? How long after you started at Inspiration was it before you succeeded in getting a result good enough to be interesting?

A. It happened on the 19th of January; having started on the 3rd of January.

X-Q. 173. And what was the rest of this six months occupied with up to June?

A. Well, we were checking results and working ores in small lots from various parts of the mine,

Ira L. Greininger.

which was very extensive. We would cut samples from various parts of the mine, amounting to a day's run, and run them through the mill.

X-Q. 174. Were there other machines operating there in competition with your standard Minerals Separation machine?

A. Not during this first period.

X-Q. 175. When were they, if you know?

A. Well, it was in 1914 when we commenced to work in the larger plant.

X-Q. 176. Then up to that time they had not decided to adopt this Minerals Separation machine?

A. Not definitely.

X-Q. 177. How long did it remain in a state of indecision?

A. Really, I could not testify as to that.

X-Q. 178. Why was it that they finally fitted up the machine with four Callow units and fourteen Inspiration units and only one Hebbard unit, if you know?

A. I don't understand you.

X-Q. 179. What led to the adoption of the system you describe, 14 Inspiration machines and 4 Callow machines and 1 Hebbard?

A. Well, I can only quote Doctor Gahl as to that.

X-Q. 180. Do not all these machines depend on the introduction of air solely for agitation?

A. Not solely.

X-Q. 181. None of them reach their results by agitation alone, do they?

A. Why, I consider it so, yes.

X-Q. 182. Which one of them does it?

A. Well, all the agitation—they all have agitation.

X-Q. 183. Which one of them brings it about by agitation without the introduction of air under pressure?

A. I did not mean to make that statement; I said agitation and aeration is performed in all the machines. Some of them introduce the air by means of the mechanical agitation; some by the introduction of air through a porous material.

X-Q. 184. Do you know what patentees the Inspiration Company has licenses from?

A. I do not.

X-Q. 185. Do you know whether they have a license from Minerals Separation?

A. I have second-hand information, that is all.

X-Q. 186. Did you ever see Mr. Callow around the Inspiration plant?

A. Certainly.

X-Q. 187. Have you seen him there lately?

A. Well, lately I am at the mines, and he might be at the plant and I would not see him.

X-Q. 188. How lately have you seen him?

A. Not since 1914.

X-Q. 189. You are not in the mill now?

A. No.

X-Q. 190. Where did they get these Callow machines?

A. They built them on the ground.

Ira L. Greininger.

X-Q. 191. Did Mr. Callow supervise their building?

A. He did not as far as I know.

X-Q. 192. Were there any name plates on there of the Callow Company?

A. There probably are, although I have not noticed them.

X-Q. 193. Was this first machine that you put in there which was called the standard Minerals Separation machine, provided with any means for introducing air, other than by mechanical agitation?

A. Not as a steady thing. We attempted to introduce air at times into the machine, but it was not designed in such a manner that it would break up the air into fine enough bubbles.

X-Q. 194. What was the reason, if you know, that the standard Minerals Separation machine was not successful?

A. As I said before I can only quote Dr. Gahl as to that, and he stated that the reason was a very slight difference between the power consumption between the Minerals Separation machine and the various air agitation machines.

X-Q. 195. What is the power consumption, if you know, of the standard machine as compared with the Callow machine of equal tonnage?

A. I could not give you any definite figure as to that.

X-Q. 196. You never looked into that?

A. No, I have had no chance to compare them in an accurate manner.

Ira L. Greininger.

X-Q. 197. Now, as I undertsand your testimony, the final extraction of mineral from the ore is effected on tables, after the flotation treatment has taken place?

A. A very small portion of the mineral is extracted on tables.

X-Q. 198. But the last of it that goes through after flotation is not that it?

A. That is quite right.

X-Q. 199. Do you, in any of these machines at the Inspiration plant, return any of the concentrates as middlings to the head of the machine?

A. Not strictly speaking, as I understand it, no. The tails from the cleaner machine are returned, of course.

X-Q. 200. Yes, I remember you said that.

A. Not aside from that.

X-Q. 201. None of the rougher concentrate goes back to the head as a middling?

A. No.

X-Q. 202. How about the practice at the Britannia, did they return any of the rougher concentrate as middlings?

A. During the time I was there I returned two spitzkastens out of the seven or eight, whichever I happened to be using, as a middling.

X-Q. 203. Returned it direct to the head of the machine or back to some tank?

A. Direct to the head of the machine.

X-Q. 204. Now, you have stated certain facts as to the recovery and the grade of concentrates at Inspira-

Ira L. Greininger.

tion. If I remember right, if my memory serves me right you did so state. If not, you may state now.

A. As to what period?

X-Q. 205. Well, state recently.

A. I have only the annual report of the company on which to base a statement of that kind, as I am not, as I said, in direct touch with the milling operations at the present time. They give the extraction in their annual report as about 90% of the sulphide; somewhere over 90%.

X-Q. 206. The practice adopted at Inspiration is quite similar to that of the Miami isn't it?

A. I am not familiar with that practice.

X-Q. 207. The Miami mine uses Callow cells?

A. Yes.

X-Q. 208. And at the Inspiration you say they used Callow cells ~~at~~ and the Inspiration machine. Now, they are quite similar in appearance, aren't they?

A. Both of them are similar.

X-Q. 209. Both of them depend upon introducing the air through a porous bottom?

A. Both types.

X-Q. 210. As distinguished from introducing it by mechanical agitation?

A. They do.

X-Q. 211. The Miami property was started and in operation some year or more before the Inspiration, wasn't it?

A. Several years before.

X-Q. 212. Well, I mean the flotation department?

A. I don't understand it that way.

X-Q. 213. The flotation department, I mean.

A. At Miami?

X-Q. 214. Yes.

A. Installed before Inspiration?

X-Q. 215. Yes.

A. Oh, no.

X-Q. 216. What was the Inspiration doing at the time Miami started; what kind of machines did they have?

A. They were developing their mine; they didn't commence to produce ore until 1915.

X-Q. 217. Who didn't?

A. The Inspiration.

X-Q. 218. You said, didn't you, you said 1913, wasn't it, that you started there?

A. The first installation of flotation at the Inspiration was 1913.

X-Q. 219. And how long was it before some other type of machine was introduced at Inspiration other than the standard mechanical agitation machine you put in?

A. About a year and a half.

X-Q. 220. That would bring it up, then, to some time in 1914, wouldn't it?

A. During 1914.

X-Q. 221. They then started in one of these air machines with the porous bottoms?

A. Installed the air machine in July, 1914.

X-Q. 222. There was a kind of competition, wasn't

there, to decide what kind of machines should be put in?

A. Well, yes.

X-Q. 223. Mr. Callow had his porous bottom machine in there and Mr. Towne had his porous bottom machine and you had your mechanical agitating machine?

A. That is right.

X-Q. 224. And after that competition the decision came as to what kind of apparatus to put in?

A. That is correct.

X-Q. 225. Have you got any information that enables you to state daily and average results at the Inspiration Company with these different types of machines?

A. I know the results are very close, but that is second-hand information. Of course really I haven't seen the assays, you know. They are stated to be very close, one machine having no advantage over the other.

X-Q. 226. But finally they decided on these air machines and air machines are now being used, are they?

A. They are using them.

X-Q. 227. And you do not know whether they have any license from anybody besides the Minerals Separation, do you?

A. I do not.

X-Q. 228. Have you any detailed statement at all other than the annual report of the Inspiration Company showing the results from day to day?

A. Well, no, not directly; I get a certain part of

the work, it comes direct to me each day, but not the extraction, or figures that would show the extraction.

X-Q. 229. What does come to you?

A. Tonnage and assay of feed and assay of oxide and so on.

X-Q. 230. Just the figures relative to the head?

A. Yes.

X-Q. 231. You don't get anything about the concentrates or recoveries?

A. Not officially.

X-Q. 232. How do you get it if you don't get it officially?

A. As I stated a moment ago, I can only give you the figures as published in their annual report.

X-Q. 233. That is all you know about it, is it; the annual reports?

A. Since I left the plant, in the latter part of 1915.

X-Q. 234. How about before the latter part of 1915?

A. I received daily reports of the assays from all machines up to the time I left, concentrates.

X-Q. 235. Have you, in your possession, these reports covering the period of the competition between the different companies that wanted to install flotation there?

A. I have some reports covering a portion of this period.

X-Q. 236. Have you them where you can produce them?

A. I think I can produce some of them.

X-Q. 237. Please do so.

(Witness produces reports.)

X-Q. 238. Are these all you have on that subject, or simply part of them?

A. These are all I have here.

X-Q. 239. You have more somewhere else?

A. I undoubtedly have reports at home.

X-Q. 240. How long a period do these reports cover that you have in your hand?

A. I am not sure of that; I will have to look at them to find out.

X-Q. 241. I wish you would look at them and tell me, please.

A. I have some daily reports here for August 15. These do not seem to be arranged in order. I don't know what other months will be represented here.

X-Q. 242. Now, if you will just examine them and find out whether they cover a continuous period and between what period; I would like to know.

A. They apparently cover the year 1915 from January to the latter part of August.

X-Q. 243. Now, during that period what machines were in use at the Inspiration?

A. The Minerals Separation standard machine was in use; the Minerals Separation of the Hebbard type.

X-Q. 244. The Hebbard type is the one that takes in air from the bottom under pressure?

A. Yes, a system of Callow cells and what is known as the Flynn-Towne or Towne-Flynn machine and a Cole machine.

X-Q. 245. What is the Cole machine?

A. It is a machine of the same type.

X-Q. 246. Getting agitation by blowing in air through a porous medium?

A. Yes, sir.

X-Q. 247. How long did this competition between these different processes continue? When did it begin and when did it end?

A. It commenced about July, 1914, as I remember it. The Callow plant was first installed, and I suppose it could have been said to have ended when they decided what they were to install, but as to what time I am not exactly certain; some time in 1915, the early part of the summer of 1915, probably about a year I would say.

X-Q. 248. And when were these machines of the present type installed; when did they begin installing them?

A. They commenced installing them in July, 1915.

X-Q. 249. Right at the end of this competitive run?

A. Toward the end of the competitive run, I should say.

X-Q. 250. Were these other machines taken out upon the termination, and the Cole?

A. Yes.

X-Q. 251. They were not in the mill where they? They were in a separate building.

A. They were in an adjacent building. You might say they were under the same roof. They were not operated possibly the last two or three months. I was

in the plant. In 1915, during July and August; they discontinued operating all of these plants, including the Callow and the test mill.

X-Q. 252. You haven't any data then on the regular operation of the mill after this plant was decided upon and installed?

A. I have a few sheets here showing the daily operation as long as I was in connection with the concentration department. They had four sections of the mill and they were breaking them in one section at a time. We have first one and two, and then we have the four section.

X-Q. 253. And how long a time do these regular operation reports cover?

A. They probably cover thirty days or more. I haven't looked them over to see.

X-Q. 254. What oil was used during those 30 days?

A. They were using coal tar oil—I mean crude coal tar and creosote.

X-Q. 255. In a mixture?

A. Yes, in a mixture of a small per cent, around 10% I should say of creosote, and the balance was crude coal tar.

X-Q. 256. Will you give me for the first of the days in that period of regular operations the assay of the headings as well as the tons concentrate and the recovery, figured on sulphides?

A. The recoveries are not given. I would have to check them to give you the recoveries. Just the assays.

X-Q. 257. Give me the assays, then.

A. Just the Callow and Separations, ~~was~~ were operated on that day, which was January 1st. Feed to flotation, total copper 1.86; oxidized copper, .28; general concentrates, 22.66; Minerals Separation flotation concentrate, 25.08; rougher concentrate to subaeration, that is the Hebbard mill, 16.8, table—sand table, 3%; tails from recleaning plant flotation 12.04—that would be tails from the cleaner, flotation tails were, first shift, .25; second shift, .34; third shift, .25; oxidized copper, .26; general tails, plant, .29. That is the general sample covering the entire 24 hours, including oxidized copper. In the Callow plant the assays were: Feed, 1.37; flotation concentrates, 31.08; rougher concentrate, 17.26; tails from cleaner, 6.60; table concentrate, 24.6; flotation tails, first shift, .078; second shift, .070; third shift, .085; oxidized copper, .18; oil per ton treated, .70 pounds. That was an off day.

X-Q. 258. Do you find a day when they were both treating the same?

A. Most any other day would have been the same, yes. There seems to be a period when the Callow machine had something the matter with it. Here we have one day, January 11, 1915.

X-Q. 259. The same material? Be sure before you start reading all of them.

A. No, that wasn't the same material. This appears to have been a long series of tests for the different plants—where the different plants took the feed from separate mills. They are practically parallel, but

Ira L. Greininger.

it wasn't a case where the feed was divided between the mills.

X-Q. 260. Are there any instances where the same feed was divided between the Callow and the Minerals Separation?

A. There must be long periods covered by that condition. Here again is a case of divided feed, taking the feed from separate mills.

X-Q. 261. Well, suppose you read us that month: tell us what the feed was, and the date.

A. The date was February 22nd, 1915. Assays of head total copper, 1.37; oxide, .30%; general concentrates, 24.34%. That is the combined concentrates from all flotation machines and tables. Flotation concentrates finished, 22.2; rougher concentrates, .18.44%; cleaner tails, 9.58%; flotation tails, Mineral Separation, first shift, .42; second shift, .47; third shift, .35. To the Callow plant the feed was the same feed. Callow flotation concentrates, 23.86%; rougher concentrates, Callow, 16.8%; cleaner tails, Callow, 4.40%; general tails or flotation tails, Callow, first shift, .~~3~~67; second shift, .48; third shift, .48. These were the general tails.

X-Q. 262. Now that is over the tables?

A. Yes, that is over the tables.

X-Q. 263. Can you give the details of the day's operations?

A. The sheet states that Minerals Separation and ~~in~~ Callow plant started up at nine, M.S. ~~,~~ took feed from upper mill, tube mill and No. 10 Hardinge mill, using

Ira L. Greininger.

about 27.5 tons per hour; Callow plant took feed from No. 11 Hardinge mill about 10.5 tons per hour; Minerals Separation were treated on flotation slimes table, east side all the concentrates from flotation retreated on 50-ton plant; Callow plant tails were retreated on sand tables, west side; oil added to dry feed, before it was divided between the upper mill and the Symonds disc.

X-Q. 264. To your knowledge was the Callow machine ever overloaded; that is, run with too much tonnage during these tests?

A. Why, not that I recall at the present time.

X-Q. 265. Can't you refresh your memory from these reports?

A. It may have happened before at times. ~~There were,~~ As is noted by these reports, there were continuous changes on the feed from various mills to the various points. Of course I have no recollection of it at the present time. I would have to read these notes to find what actually occurred at the time?

X-Q. 266. What becomes of the tails of the rougher treating slimes from the Esperanza Classifiers in the Callow section?

A. Tails from the—

X-Q. 267. Roughers which are treating ~~in~~ the slime from the Esperanza classifiers.

A. They pass to waste.

X-Q. 268. They go to waste?

A. Yes.

X-Q. 269. What becomes of the cleaner cell product in the Callow system?

Ira L. Greininger.

A. First to filter and dewatered.

X-Q. 270. And how about the tails?

A. Tailings are returned to the rougher.

X-Q. 271. What rougher?

A. The Callow rougher.

X-Q. 272. The very first machine?

A. Yes.

X-Q. 273. Doesn't go to any tank or anything first?

A. Goes direct from the launder right into the machine.

X-Q. 274. Do you know what the reason is that the Hebbard machine was not used in all the sections?

A. I can only give a conclusion, and that is because it was installed too late in the test plant. The results were in and I suppose they had arrived at a conclusion by the time the Hebbard plant was installed.

X-Q. 275 Has oil ever been added to the pulp after it comes from the ball mill?

A. There have been times when a small portion of the oil was added to the pulp after it comes from the ball mill.

X-Q. 276. What was the result?

A. It had no particular effect on the result as far as I know because there was always the majority of the oil added before the ball mill, that is before grinding. This was simply a secondary operation amounting to a very small portion of the oil.

X-Q. 277. Is the agitation in the ball mill as violent as in the Hebbard machine?

A. I couldn't make a comparison as to that.

Ira L. Greininger.

X-Q. 278. How many times per minute does the ball machine rotate?

A. It rotates about 15 times per minute.

X-Q. 279. And what is the speed of the impeller in the Hebbard machine, revolutions per minute?

A. I ran at various speeds; I ran the Hebbard up to an average there, about 300 revolutions per minute.

X-Q. 280. Did you get any practical recovery with it in froth, in the way of pulp, as it came from the ball mill?

A. In what manner?

X-Q. 281. Running it out of the ball mill into the spitzkasten?

A. Never tried it.

X-Q. 282. You didn't think it was worth trying, did you?

A. I shouldn't consider it so.

X-Q. 283. Could you make a little sketch illustrating the flow as you described it on direct, through the Callow machine, the Hebbard machine, and the Minerals Separation machine and the Inspirator machine, in the Inspiration mill?

A. I can have such a sketch made for you.

X-Q. 284. You can do that could you, just with a pencil, when you are off, and bring it back?

A. I will have it made under my direction.

X-Q. 285. You described it, but it would be much clearer if you made a sketch, I think.

A. Yes.

X-Q. 286. At the time that you added pine oil as

you stated, and got a violent, poor froth, did you make any change in the amount of aeration or dilution of the pulp?

A. I didn't make any change whatever.

X-Q. 287. Simply changed the amount of oil without changing these other factors?

A. That is all.

X-Q. 288. Have you any information as to the effect of changes in dilution and aeration on the amount of oil necessary?

A. In my practice I have always attempted to hold to a given standard of dilution and the work being in the nature of experiment and test work, I have been able to hold very closely to that particular point when it was once set so that I have not had what might be called experience in a wide variation of pulp dilution.

X-Q. 289. And how much of a range in the matter of aeration has your experience covered?

A. It is very hard to measure the aeration brought about by the beating in of air mechanically.

X-Q. 290. Well, the speed of the impellers; what range of speed of the impellers does your experience include?

A. In the standard machine we have operated it at about 12 to 14 hundred peripheral feet per minute—not a very wide range.

X-Q. 291. And kept within that range?

A. Yes.

X-Q. 292. That is about as close a range as it is practicable to keep within?

Ira L. Greininger.

A. I think so.

X-Q. 293. And how about your experience in the degree of aeration in the machine where air is introduced through a porous medium, such as in the Callow machines, the Inspiration and the Hebbard?

A. The Hebbard requires a very low pressure of air because the impellers have a tendency to draw the air in, so it matters very little as long as the supply of air is available for the impellers, whether there is much pressure or not. With the Callow and other machines I have simply observed them as others have operated them, and I have had no experience with them.

X-Q. 294. Did you describe the flow of the pulp at the Britannia plant?

A. I don't believe I did.

X-Q. 295. Is it simple enough to illustrate—Do you think you could make a sketch of it?

A. I would have a very hard time making a sketch of it. I have had men pass through that plant and swear they couldn't make a sketch of it to save their life.

X-Q. 296. So complicated?

A. It was at that time, yes.

X-Q. 297. What made it so complicated?

A. The various classes of machines used, the great number of various types.

X-Q. 298. I don't understand.

A. A great number of various types of machines

Ira L. Greininger.

that were used in the plant there, being coarse jigs, fine jigs, tables and vanners—

X-Q. 299. (Interrupting.) I meant the flotation part of it.

A. The flotation is simply the regrinding fines from the jigs and the whole goes through agitating compartments and spitzkastens right straight through the whole machine.

X-Q. 300. Run right straight through a series of machines and ~~that~~ may be one or two spitzkastens coming back as middlings?

A. That was the practice, yes.

X-Q. 301. How did you determine the pounds of pulp for the net flotation results?

A. By experiment.

X-Q. 302. Yes, but I understood you to say that you had kept within a very narrow range of dilution.

A. My practice has been that that particular range, say from 25% of solids up to a maximum of 32 or 33%, gives the best results on all ore.

X-Q. 303. Did you ever work at all, outside of that narrow range?

A. I have at the Britannia works at times, when I had not control over the dilution, when I was getting feed from the mill and in a way I couldn't control it when the dilution was no doubt less than 20% solids.

X-Q. 304. But you never worked outside of these limits when you could help it?

A. No, sir.

X-Q. 305. Ever use Jones oil at the Inspiration?

A. No.

X-Q. 306. Ever use California crude oils?

A. I have attempted to use them.

X-Q. 307. California topped oil?

A. That is virtually the same oil; I never have used an oil by that name.

X-Q. 308. How fine was the material crushed in the ball machine at the Inspiration? Approximately; what screen analysis?

A. They use a very coarse screen as their standard which does not give so much information as one would like. They state that there are so many per cent. on 48 Tyler Standard screen, and don't give us much information—I have no doubt some screen analysis covering the time that I was there, but I can't remember now just what the finer sizes were, or what the percentage of the finer sizes were.

X-Q. 309. Is the water in the tailings returned for use in the mill at Inspiration?

A. It is carried to a slime settling pond a mile or more from the plant and after a period of settling is pumped back to the plant.

X-Q. 310. Any determination ever made as to how much oil was in that water that is pumped back?

A. Not to my knowledge.

X-Q. 311. While you were attempting to develop the process for the Inspiration Company, did you get any

Ira L. Greininger.

information regarding operations in other companies, other mills, to help you?

A. Why, what was sent to me at times from the office at San Francisco in regard to what others were doing; that is, other members of the Minerals Separation staff; other than that I did not.

X-Q. 312. I meant regarding the practice developed at other mills?

A. No.

X-Q. 313. Did you obtain such information in any way.

A. Only by the installation of these machines. Other than the Minerals Separation machine at the Inspiration plant.

X-Q. 314. Any iron sulphide in the Inspiration ores?

A. Very little.

X-Q. 315. Did the Inspiration Company have others besides you working on the application of flotation in their ore?

A. Not at the time of my first work at the Inspiration. The first six months period the Inspiration was simply represented by a gentleman who checked our results. Starting the large plant, the company had their present metallurgist, Dr. Rudolph Gahl at the plant, and he has been there continuously since.

MR. SCOTT: That will be all.

Ira L. Greininger.

RE-DIRECT EXAMINATION,

BY MR. WILLIAMS:

R-Q. 316. Now, in the standard machine of Minerals Separation such as you have described, where does the air come from that gets into the pulp?

A. It comes from the surface and goes down in a vortex which forms around the impeller shaft, when the ~~flotation~~ agitation has reached a certain speed.

R-Q. 31~~4~~7. And I have a suggestion for that kind of aeration as to the name, supra-aeration. Will you adopt that name?

A. I think it describes it.

R-Q. 318. In the Hebbard type of machine where does the air come from?

A. It is brought in from below, the opening being under the center of each impeller.

R-Q. 319. ~~And there~~—And that has a name has it not?

A. That has.

R-Q. 320. What is it?

A. We term it sub-aeration.

R-Q. 321. Now the Callow cell, is th~~is~~e ~~air~~ pulp in that not sub-aerated?

A. I would consider it so.

R-Q. 322. And in the Inspiration machine is that or is it not sub-aerated?

A. It is sub-aerated.

R-Q. 323. Who was president of the Inspiration

Ira L. Greininger.

Consolidated Copper Company at the time of this competition that you have just testified about?

A. I think Mr. Thompson was president at that time.

R-Q. 324. And he is the man, Mr. William B Thompson, he is the president of the Callow Company?

A. I think he is.

R-Q. 325. Now, what becomes of the slimes from the Minerals Separation machine in the Inspiration plant?

A. After classifying, the slimes are passed to waste; the sands being passed over tables.

R-Q. 326. And what is the result of that as to the coarser particles? The coarsest particles go first through what?

A. The coarser particles are dragged by this drag classifier and are then carried to a hydraulic classifier where they are again classified and distributed.

R-Q. 327. And about what proportion of the recovery is made on those tables?

A. During my time at the plant the proportion of recovery only amounted to two or three per cent of the total recovery.

R-Q. 328. And everything else is made on flotation?

A. On flotation.

R-Q. 329. I did not ask you on direct about an installation at the Old Dominion Copper Company. Did you make an installation there of flotation?

Ira L. Greininger.

A. I did.

R-Q. 330. What was the installation?

A. That was our usual experimental apparatus, the 50 ton standard unit.

R-Q. 331. How long were you with that plant, and what results did you obtain?

A. I was with the plant about two months in the latter part of 1913.

R-Q. 332. What did you decide upon as the frothing agent to be used?

A. We used a number of oils experimentally, as we usually did, but cresol and the like products gave the best results, such as creosote or cresol.

R-Q. 333. Was that or was it not a difficult ore to treat by flotation?

A. It was a very difficult ore, from the fact that it contained a large amount of clay, and also a very large amount of oxidized copper in proportion to the amount of copper in the ore.

R-Q. 334. How would you describe that ore of the Old Dominion mine?

A. Treatment by flotation was a very difficult matter, and I warned the company when I installed the plant that they probably would not get very good results but as the material we were treating was absolute waste to them at that time, and we were able to get fair extraction, around fifty per cent of the total copper, they were very much taken with it, and decided to install a plant, which has since greatly in-

Ira L. Greininger.

creased their extraction, although on different ore.

R-Q. 335. Isn't that ore there mostly smelting ore?

A. Yes; their concentrating is secondary to the smelting ore. When it gets below a certain grade it goes to the concentrator, but above that grade it goes direct to the smelter.

RE-CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 336. Do you know William B. Thompson?

A. I do.

X-Q. 337. Was he president of the Inspiration Company when the big mill was built?

A. As far as I know he was.

X-Q. 338. Do you know that?

A. I don't know for a certainty.

X-Q. 339. You don't know when his term of office started, do you?

A. I think he has been president of the company continuously since.

X-Q. 340. But you don't know that?

A. Only by the reports.

X-Q. 341. You don't know anything about his being president of your own knowledge?

A. Well, I suppose that would be the best evidence anybody would have, not having been present at the directors meeting, was to see his name on the annual report.

X-Q. 342. Do you know who is president now?

A. Mr. Thompson is.

R X-Q. 343. You have been told so I suppose.

A. Well, I was talking to Mr. Thompson about three weeks ago, and that came up in the conversation.

WITNESS EXCUSED.

GEORGE A. CHAPMAN, called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. WILLIAMS:

Q. 1. You are the same George Albert Chapman who testified in the suit of Minerals Separation against Hyde, are you not?

A. I am.

Q. 2. In your testimony in that suit you carried your connection with flotation installation up to about the summer of 1912, when the testimony in London was closed?

A. Yes.

Q. 3. Now, will you take up that record and continue with it; what did you do after that time in installing flotation concentration of ores; what was the next thing you did?

A. Well, in December, 1912, I came to the United States of America and proceeded to Miami, Arizona, and there assisted Mr. Greninger in his first tests at the property of the Inspiration Company. I stayed there for a period of about three months and then

George A. Chapman.

I came to Butte to assist in the demonstration before this court at the argument of the Hyde case. After that I returned to Miami for a period of another eight or ten weeks, till the tests of the 50 ton plant were completed. They were completed in either the month of June or July, and from there I went to San Francisco and worked in the laboratory of Mr. Nutter, testing ores for clients of the company.

Q. 4. That was the laboratory of Minerals Separation, American Syndicate?

A. Yes. Then about September I left for Chili, South America, via New York, to assist Mr. Walter Broadridge.

Q. 5. And who was Mr. Broadridge?

A. The chief engineer of Minerals Separation at London—in the reorganization of the concentrator at the Braden Copper Company. When I reached there, there were seven 600 ton standard Minerals Separation machines in operation, and the results had not come up to expectations; but these poor results were soon traced to the bad milling conditions in the upper part of the mill, and were not at all due to any of the work in the flotation section. Before remodeling that mill, we had handed over to us for testing purposes a 500 ton mill in which we were allowed to carry out our tests in order to satisfy the officials of the Braden Copper Company that we could improve their general milling practice. The recovery in this old mill at the time of our arrival was in the neighborhood of sixty-

George A. Chapman.

five per cent or a little above that. In our first month's work we raised that recovery to either 79.8 or 79.9 per cent of the total copper contained in the crude ore. The following month the recovery was slightly in excess of eighty per cent. It was after the successful demonstrations in this mill that Mr. Pope Yeatman, who was present on the property consented to the reorganization of the larger mill. This reorganization was well in hand at the end of December, and the only trouble then that they had apparently was the collection of the flotation concentrates. Having in mind the hearing of the argument in the appeal court at San Francisco, I completed my stay at Braden, and on my return, at Lima I received a cablegram from the New York office, asking me to visit the El Cobre mines in San ~~Diego~~ tiago,—near San tiago ~~Diego~~, Cuba.

Q. 6. You said that the recovery was as to total copper; what did the ore contain in copper; anything besides sulphide?

A. Oh, yes, it contained some carbonate and oxide.

Q. 7. And what was the recovery in sulphide copper?

A. Well, I should say between ninety and ninety-five per cent.

Q. 8. Now, as to the El Cobre mines in Cuba?

A. I found there a mill that was operating on about 500 tons of copper ore, assaying four per cent cop-

George A. Chapman.

per, and installed in that concentrator was one standard 600 ton M. S. machine, the recoveries being obtained at that time were improved to the neighborhood of about eighty per cent total copper, and I made certain recommenadtions and promised the management that they would get a recovery of about eighty-five per cent, which I think they have succeeded in doing since.

Q. 9. Was there or was there not an oxidized copper constituent in that ore?

A. Well, the trouble with that ore was that a lot of material that was hauled from under ground contained large quantities of filling of old tailings that had been used in old stoping operations.

Q. 10. That was a very old mine, was it not?

A. Very old.

Q. 11. Do you know how far it goes back historically?

A. I could not say, but it was very old, and it was the presence of these old tailings that was causing considerable difficulty in the mill. I left Cuba for New York, and then returned to Miami, Arizona, where Mr. Greninger had already got the 600 ton testing plant in operation. I stayed there a few weeks, and then visited the property of the Consolidated Arizona Copper Company at Humboldt.

Q. 12. You have heard Mr. Greninger's testimony in regard to the operations at the Inspiration. Are you in agreement with what he said?

MR. KREMER: We object to that form of question, asking one witness if he agrees with another.

MR. WILLIAMS: It is just to save time.

MR. KREMER: He has not seen the operations, he has only been there part of the time.

Q. 13. On your first visit to Inspiration, how long did you stay there?

A. About three months.

Q. 14. And during that three months were the operations of the flotation plant successful?

A. Entirely successful.

Q. 15. And about what recoveries were made?

A. Why, they varied considerably, according to the part of the mine the ore came from, but I should say from memory that they varied from 85 to 95 per cent recovery of the sulphide mineral present. There was one occasion when we got as high as 97 per cent copper. This recovery of course varied as we were treating daily 10 ton lots of ore which were being taken from all parts of the mine, to allow the management to fully appreciate the value of flotation to them as to the whole of their ores.

Q. 16. Did you introduce at Inspiration any method of treatment in connection with flotation?

A. I did.

Q. 17. And what was it that you introduced?

A. I introduced a method which was known as modifying during grinding, which was an improvement on a previous preagitation method.

George A. Chapman.

Q. 18. And that was patented to you, was it not?

A. It was.

Q. 19. And the patent belongs to Minerals Separation, Limited?

A. Yes.

Q. 20. Now on your second visit to Inspiration how long did you stay there?

A. A few weeks only.

Q. 21. And operations were being carried on while you were there?

A. The operations at that time were partly a combination treatment of water concentration and flotation, and partly total flotation treatment. Mr. Greninger and myself took separate shifts, and for a few weeks we had a friendly contest as to which was the best method, and I think it was finally agreed that the total flotation gave practically the same results as water concentration plus flotation. If there was any little balance, it was in favor of water concentration plus flotation, for the reason that on days when the crushing was too coarse, the wet concentrating tables recovered a few extra per cent of copper by saving the over size mineral.

Q. 22. And in those operations where was the water concentration in relation to flotation?

A. Both before and after, according to the flow sheet being employed.

Q. 23. And what frothing agent was used then and in what proportion?

A. Cresylic acid was the chief agent used, and

occasionally we had in combination with that, pine oil and turpentine, and it was used, if I remember correctly at the rate of about one and a half pounds per ton of crude ore treated.

Q. 24. Now, we will take up the Consolidated Arizona Copper Company, where is that?

A. At Humboldt, Arizona.

Q. 25. And what did you find there, and what did you do there?

A. I found a 100 to 150 tons standard Minerals Separation machine operating on a copper ore. My visit was purely one of inspection to see if I could assist them in any way.

Q. 26. Did you study the operations?

A. Yes.

Q. 27. What frothing agents were used while you were there and in what proportion?

A. Well, if I remember correctly, there was quite a number there—I would have to refer to notes.

Q. 28. What proportion?

A. I can't recollect the exact proportion; it was very low; it was in the usual amount that we used at that time.

Q. 29. Well about how much?

A. Between two and four pounds per ton.

Q. 30. Do you remember what recoveries were obtained while you were there?

A. I do not recollect them, but I can give them to you by referring to my notes.

(Recess.)

George A. Chapman.

Q. 31. I think I misled you as to the title of the Consolidated Arizona. I will ask you now if the proper title is not the Consolidated Arizona Smelting Company?

A. That is correct.

Q. 32. Now, will you give me the information that you were not able to recollect in the last few questions.

MR. KREMER: Pardon me, Mr. Williams, but I would like to make an inquiry; these figures that Mr. Chapman is giving represent milling operations, do they, under our stipulation?

MR. WILLIAMS: Oh, yes.

MR. KREMER: I want to inquire to avoid the necessity of objecting; they are not tests; they are milling operations?

MR. WILLIAMS: Oh, yes.

Q. 33. What were these operations at the Consolidated Arizona while you were there?

A. They were the usual daily milling operations.

Q. 34. And you gave them study for the purpose of what?

A. Increasing their recovery.

MR. KREMER: I think that is covered by our stipulation.

Q. 35. I think I asked you about the frothing agents used?

A. The frothing agent used at that plant was a mixture of fuel oil and stove oil and Carolina turpentine.

George A. Chapman.

Q. 36. In what proportion?

A. It varied between two and three pounds per ton.

Q. 37. How about the recoveries?

A. The recovery we obtained at that time was in the neighborhood of eighty per cent, and has increased considerably. On my last visit to Consolidated Arizona in 1916 the recoveries were 93 or 94 per cent.

Q. 38. Was there oxidized copper?

A. Very little.

Q. 39. So it did not figure to speak of?

A. The sulphide copper was practically the recovery that we got. The mineral was a little tarnished, of course.

Q. 40. Could you give me the percentage of the three oils which were used in the proportion of two or three pounds per ton of ore, fuel oil, stove oil and Carolina turpentine?

A. Well, I have no definite notes on that, but speaking from memory—about 50 per cent of the mixture was Carolina turpentine and the other 50 per cent was divided between the stove oil and the fuel oil, the major portion of which was fuel oil.

Q. 41. Now, up to this period have you covered the various installations made by you?

A. Yes.

Q. 42. What was the next work that you did?

A. In June, 1914, I again came to this district to carry out large scale tests of the products from the Washoe concentrator of the Anaconda Copper Com-

George A. Chapman.

pany. These were started in the month of June, 1914. About the same time Senator Clark's Timber Butte mill was about to be started up, and as much spare time as I could devote to that I spent at the Timber Butte mill.

Q. 43. Did you study the operations of the Timber Butte mill?

A. I did.

Q. 44. And what in general was the nature of those operations as to the frothing agents used?

A. We started up on pine oil, and oleic acid, in the neighborhood of one pound per ton, and we got very good results right from the start.

Q. 45. About what percentage of recoveries?

A. Well, I think the first week's results was over ninety per cent of recoveries.

Q. 46. But you gave the greater part of your time to the Anaconda work?

A. The Anaconda work, because Mr. Tom Owen was at Timber Butte looking after our interests at that time, and I spent perhaps three half days a week in that mill.

Q. 47. What was the nature of the work at Anaconda?

A. I was to carry out a complete investigation on a practical scale of the applicability of flotation to their slimes, and also to their sand tailings. The first work we undertook was on the Anaconda slimes, and we succeeded in geting very encouraging results.

George A. Chapman.

which lead the officials of the Anaconda Company to recommend the installation of a large flotation plant for the treatment of this product. After successfully demonstrating the process on these slimes, it became a matter of investigation whether it would be more economical to treat the straight slimes or the tailings from the Round Table plant, which was then in operation on that product. Our tests demonstrated that the operation would be much more simplified if we treated the Round Table feed direct, and plans for an installation on a very large scale were proceeded with. In the meantime, the success of our work on the slimes influenced our friends at Anaconda to investigate the possibilities of the treatment of sand tailings and to compare the results with the leaching process which was then in operation. As a result of these tests it was decided to reorganize the whole of their concentrating and increase their tonnage to 15,000 tons per day of crude ore. The upper part of the mill had slight modifications. It was decided to treat all tailings from the tables by regrinding them and subjecting them to flotation treatment. Eight sections of the mill were so changed, and each section had installed in it four 600 ton standard M. S. machines. Each part of the flotation section would treat in the neighborhood of 1350 tons a day, using only three machines, and keeping one machine in each section as a spare.

Q. 48. What became of that Round Table plant?

George A. Chapman.

A. The round table plant was scrapped as soon as the slime flotation plant was put in operation.

Q. 49. How long did you stay at Anaconda?

A. On and off I made Anaconda my headquarters until just before Christmas of 1916.

Q. 50. You were present during all this great work of installation?

A. I was present a good deal of the time.

Q. 51. And represented Minerals Separation, Limited?

A. I did.

Q. 52. Or the American Syndicate?

A. Yes.

Q. 53. What was the method of the relation of water concentration to flotation?

A. You mean at Anaconda?

Q. 54. At Anaconda?

A. The tailings, after treatment through jigs and tables, were reground in a Hardinge mill, and the reground product passed direct to the flotation machines At the head of these machines was added wood creosote and kerosene ~~and~~ acid sludge, with sulphuric acid, and the usual methods of flotation were followed out. The concentrates recovered from the flotation machine passed to a system of Dorr thickeners, the product of which went through to Oliver filters, and after filtration by these machines the concentrates were mechanically conveyed to railway cars ready for the smelter.

Q. 55. Where did the slimes go from the slime plant?

George A. Chapman.

A. The feed for the slime plant was separated in the upper part of the mill.

Q. 56. By what means of mechanism?

A. By means of an Anaconda classifier. The slimes were then passed to the original Dorr thickening plant which was employed for the thickening of the slimes in the original round table treatment. It was not necessary to alter the condition of this thickening plant, as the economical pulp thickness derived from settlement was quite suitable for both the round table plant and the flotation treatment, namely, in the neighborhood of 14 to 15 per cent solids. The same reagents were used in the slime flotation plant, as in the reground tailings flotation plant, and very high recoveries were obtained. The concentrates from the slimes flotation plant were handled in the same manner as the sand flotation plant.

Q. 57. Now, what you have described is what part of the mill treating what ore?

A. It treats the ore from the Anaconda mines at Butte.

Q. 58. What kind of ore?

A. Copper ore.

Q. 59. Now, was there an installation of a plant for zinc ore?

A. There was one installation made last year at Anaconda.

Q. 60. You might briefly describe that plant; that was under your superintendence and in your presence?

George A. Chapman.

A. Yes. This plant had a rated capacity of 2000 tons per day. The method of treatment was total flotation, and was unique on account of the absence of any water concentrating device in the zinc concentrate.

Q. 61. What does the mill consist of, the flotation mill?

A. The mill consists of the usual coarse crushers, Hardinge mills, Dorr classifier and the products from the Dorr classifier pass direct to flotation machines, where one retreatment of the concentrate was given.

Q. 62. And no water concentration at all?

A. Absolutely no water concentration at all in this mill. The absence of water concentration was a distinct advantage in the capital cost of the concentrator and also in the working cost, which I think has never been approached in this district.

Q. 63. In this particular instance, as to this plant, what is done with the zinc concentrates?

A. The zinc concentrates are filtered and were for some months treated by the new electrolytic methods at Anaconda, but now those concentrates are shipped to Great Falls, where they are treated in the new electrolytic plant in Great Falls.

Q. 64. That is to say the zinc is not produced by smelting—but by electrolytic deposition?

A. ~~Electric~~ deposition. Electrolytic

Q. 65. Did you have any competition during the long period of testing or preparation and installation in this plant?

A. Yes; we had a representative of Mr. Callow's present, who was testing out the Callow machines on practically the same feeds as those we were doing our flotation work on.

Q. 66. Are any of those Callow machines now in the plant?

A. They are not.

Q. 67. Now, is there any other installation that you can refer to as made by you or examined by you?

A. Yes, sir. In 1916 I made several visits throughout the country, and I visited again the Inspiration, the Old Dominion, the Consolidated Arizona, the St. Joseph Lead Company's property at St. Joseph, Missouri, the Doe Run Lead Company and also visited the Cripple Creek district and inspected the flotation operations of the Portland mine, Gold Mining Company, and the installation at the Vindicator Gold Mining Company, and also visited an installation at Leadville, owned by Mr. McDonald.

Q. 68. And were or were not all these places at which flotation was installed under the direction of your company?

A. They were installed under the direction of our company.

Q. 69. What did you find at the Old Dominion Copper Company?

A. They had a standard M. S. machine in operation.

Q. 70. Was it operating in a satisfactory manner?

A. Well, in 1915 they had considerable milling dif-

George A. Chapman.

ficulties, and they were only operating the mill two shifts a day, and we made certain recommendations in a report to Mr. Nutter, which he conveyed to Mr. Beckett, general manager of the Old Dominion Copper Company, and in the following year when we visited the Miami district at the time of the trial or the preparation for the trial against the Miami Copper Company, I again received instructions from Mr. Nutter, stating that Mr. Beckett had asked me to visit their flotation plant, which I did. I found the work considerably improved, and that they had carried out many of the recommendations we made the previous year.

Q. 71. Now, in all your experience in the installation of Minerals Separation concentration processes the world over, of which you have testified, Australia, Sweden, Finland, Chili, South America, Canada, Cuba, and the mining districts of the United States, what is the largest amount of frothing agent that you ever used in any regular operations at a plant?

A. The largest I recollect ever having been used was that at the Old Dominion plant.

Q. 72. And how much was that?

A. Between six and seven pounds per ton.

Q. 73. And what was their frothing agent?

A. I would like to refer to some reports. This report is dated May 21st, 1916, from the Old Dominion period. In that report I mentioned that the average for the first 15 days of April, 1916, the oil consumption average was as follows Coal tar 6.18 pounds per

George A. Chapman.

ton; coal tar creosote, 0.52 pounds per ton; pine oil, 0.20 pounds per ton; turpentine, 0.26 pounds per ton.

Q. 74. And what you referred to was the document which you now hold, which was your report to Mr. Nutter dated May 21, 1916; is that correct?

A. That is it.

MR. WILLIAMS: The document is offered to defendant's counsel for inspection. That is all.

CROSS EXAMINATION.

BY MR. SCOTT:

X-Q. 75. Did you state what the composition of the ore was where you used the oil that was last referred to by you? If you did not, I wish you would.

A. Well, it was copper ore and the feed to the flotation machine contained about 70.5% of Al_2O_3. (Alumina) That is in connection with the getting of the determination of the clay contents of the ore.

X-Q. 76. And did you give the copper; did you tell us before what form the copper was in?

A. The feed averaged 2.55% copper. This was in the form of sulphide chiefly.

X-Q. 77. What kind of a concentrate?

A. The concentrate averaged 18.38% of copper, 22% of iron, 28% of sulphur and 25% of insoluble. The tailings averaged .76% total copper, the extraction was 73% copper.

X-Q. 78. You gave us before that oil composition?

A. Yes, I gave that.

X-Q. 79. Have you got the iron in the feed?

George A. Chapman.

A. No, I don't think I have, Mr. Scott—No.

X-Q. 80. You stated that when you arrived at Braden things were not coming up to expectation. What was the trouble?

A. Well, comparatively the whole trouble was in bad superintendence of the milling operations.

X-Q. 81. And how about the flotation itself?

A. The flotation plant itself was mechanically correct but the feed being delivered to the machine at the time I arrived could not be considered at all suitable for any successful operation.

X-Q. 82. What was the trouble with it?

A. The feed was very irregular. The size of the feed delivered was found to be much too coarse. There were constant shut downs owing to power trouble, and the constant starting up of the flotation machines after being shut down under load, naturally caused bad work in that section.

X-Q. 83. What is fuel oil, petroleum oil? Is it mineral oil?

A. I should say so, yes.

X-Q. 84. And stove oil also is mineral oil?

A. Is a mineral oil—In a more purified form.

X-Q. 85. Any reagent such as salts or acids used at Inspiration?

A. Not to my knowledge.

X-Q. 86. You do not know of any mineral reagent being used there?

A. No.

X-Q. 87. How about old Dominion?

A. Sodium sulphate has been used and caustic soda has been used.

X-Q. 88. And how about the Timber Butte?

A. Timber Butte, chiefly sulphuric acid. That is the only reagent I have noticed outside of oily reagents.

X-Q. 89. And the Anaconda?

A. Sulphuric acid entirely.

X-Q. 90. No others?

A. Well, no, occasional tests with sodium sulphate, and at one time when I was away from Anaconda they ran one section of the mill for some time with caustic soda.

X-Q. 91. What was their regular practice, do you know?

A. Sulphuric acid.

X-Q. 92. Alone?

A. Alone.

X-Q. 93. And the Arizona Consolidated, what mineral reagents, if any?

A. Sulphuric acid.

X-Q. 94. And the ore treated at the Timber Butte mill was very similar to that of the Butte & Superior was it not?

A. It used to be but not now.

X-Q. 95. Are you sure that you do not know of any mineral reagent being used at Inspiration?

A. Not at any time when I have been there. The only time was in the early days of 1913 when we certainly did try out acids and alkali, but in practical operations I know of none.

George A. Chapman.

X-Q. 96. What exactly did you mean by saying that the ore treated by the Timber Butte mill used to be similar to the Butte & Superior but is not now?

A. Why, of course I am judging the samples of Butte & Superior ore by those that we have come in contact with in the various suits. Of course the first time I visited your mill was last Sunday week, and I can only say that the ore that was going through the mill on that occasion apparently contained a great deal more clayey material than any material I have ever seen pass through the Timber Butte mill.

X-Q. 97. And in the past when you have had opportunity to compare the two ores you did notice that difference?

A. I didn't notice any remarkable difference.

X-Q. 98. What was your first operation when you started in to apply this process of Minerals Separation to the Anaconda slimes laboratory work?

A. I beg your pardon?

X-Q. 99. —laboratory work, the first thing?

A. No, I never conducted a single laboratory test in the Anaconda before starting.

X-Q. 100. You started with a 50-ton Minerals Separation machine?

A. No, it was a standard 200-ton Minerals Separation machine which of course would have its capacity much reduced owing to the thickness of the pulp that we were about to treat. Its capacity on sand would be 200 tons per day but on slimes only 60 or 70 tons per day.

George A. Chapman.

X-Q. 101. You said something about 15% solids?

A. About 15% is a good average.

X-Q. 102. And what per cent did you have at the beginning of your operation?

A. Well, for the first few days of course we went through the usual trouble of selecting reagents and naturally tried to avoid the use of sulphuric acid but after a few days of experimenting it was evident that sulphuric acid in this treatment greatly simplified matters and we went straight ahead to get the best reagent to combine with sulphuric acid.

X-Q. 103. And what do you refer to by "reagent to combine with sulphuric acid"?

A. I refer to the oily reagents.

X-Q. 104. And to what oils did you direct your energies, in that direction?

A. Well, the main oils of course at that time were creosote, pine oil, kerosene acid sludge. We also tried reagents in various forms,—feeding them directly to the machines, also by pre-agitating them, adding them to the machine straight. We tried the effect of a compound by the name of argol, adding that to the machine.

X-Q. 105. A-r-g-o-l ?

A. Yes.

X-Q. 106. What is that?

A. That is a crude acitate of potassium. It is a by product from the wine industry.

X-Q. 107. What oils were they using on the occasion of your last knowledge of the work at Anaconda?

P. 4113, L. 9, insert "and two pounds of acid sludge. That figure for creosote" after "osote"

George A. Chapman.

A. Acid sludge and creosote.

X-Q. 108. And what quantity were they using?

A. That I can't say, but I can get that for you definitely, perhaps.

X-Q. 109. What quantities were they using the last time you have knowledge of?

A. Possibly two pounds of each, two pounds of creosote may be rather high. I would prefer if you would allow me to refer to my reports.

X-Q. 110. What is this acid sludge? An oil or an acid, which?

A. It is a by-product from the paraffine industry. I have never really gone into it fully, but in simple language I should say it was a solution of oil in acid, sulphuric acid, which is in itself soluble in water, although the original oil in the acid-oil mixture is insoluble in water.

X-Q. 111. Are you the George A. Chapman who was sent to the Sulphide Corporation at Broken Hill, Australia, in 1904?

A. I am.

X-Q. 112. Did you meet Mr. James Hebbard there?

A. I did.

X-Q. 113. What process was Mr. Hebbard using at that time?

A. Why, beyond the ordinary wet concentration method?

X-Q. 114. Yes.

A. I don't know of any other process.

X-Q. 115. Who was Mr. Hebbard?

A. Mr. Hebbard was the manager of the Sulphide Corporation, Central Mine.

X-Q. 116. Don't you know that Mr. Hebbard had been doing something with the Cattermole process?

A. I don't think Mr. Hebbard ever did any tests on the Cattermole process until I arrived.

X-Q. 117. When did you arrive?

A. Why, in 1904.

X-Q. 118. Did you work with Mr. Hebbard?

MR. WILLIAMS: It is respectfully submitted that the witness is not being cross examined on matters in relation to which he was examined on direct. He may have testified in the Hyde suit, but certainly not as to any matters that were brought out in this direct examination. His testimony started with 1912. Counsel now carries him back to 1904, his experiments in Australia, and matters that apparently are not in any way germane to the direct testimony. I object to the question as irrelevant and unwarranted and not proper cross examination.

MR. SCOTT: The witness testified about operations throughout the world and that is what I am cross examining him about. I should not think the counsel could claim the privilege of confining the cross examination to any particular year. The examination is on the subject as to what processes have been in use.

THE COURT: Well, when he was testifying about world-wide operations he was testifying about the process in suit, and all the operations of the process in

George A. Chapman.

suit, South America, Australia, etc., that he had not known to be used more than 6 or 7 pounds of oil to the ton. I think you are getting a little beyond the legitimate cross examination.

MR. SCOTT: The plaintiffs have examined him directly in an effort to show the court, or an attempt to show the wide application of this process to the exclusion of others. My questions are directed to negative that inference.

THE COURT: Well, but you are going outside of it. You may ask him anything in connection with this process, whether it has been used in Australia. It would not negative the use of the process in Australia if they had also used the Cattermole process or if the gentleman mentioned had. I think I will sustain the objection of that question.

MR. SCOTT: Exception.

X-Q. 119. Did you state, Mr. Chapman, that at the time of your visit to Inspiration they were making a recovery of 85% to 95%?

A. That was the first three months, in the experimental part.

X-Q. 120. And what recoveries are they making now?

A. I couldn't say, Mr. Scott. You see my visits have been very occasional since then.

X-Q. 121. Do the figures that you gave take into account the percentage of oxides in the tailings when speaking of the recovery?

George A. Chapman.

A. These figures refer to the recovery of sulphides; I thought that was undertsood.

X-Q. 122. Maybe you did say that. Was the slime and reground sand feed ever mixed and sent to the flotation plant as a mixed product at Anaconda?

A. Yes, it has been tried.

X-Q. 123. What grade of flotation concentrate did that make at Anaconda?

A. Well, the concentrates from the sand plant varied from 30 to 35 insoluble material, and from the slime plant a little more. In this particular instance I was given to understand that it was not necessary to improve the grade beyond this; that it was fully suitable to their smelting requirements.

X-Q. 124. Did you ever use this stove oil and fuel oil at Anaconda, under your direction?

A. Oh, yes.

X-Q. 125. For what periods of time?

A. Why, right throughout the testing period, we used a little stove oil to assist in the uniformity of the work of the plant.

X-Q. 126. And that recovery which you have given of 85 to 95% on the sulphide content would be about what on the copper content as a whole?

A. Shall I take an average recovery of 90% of the sulphide for the purpose of this calculation?

X-Q. 127. Yes.

A. In the neighborhood of 77% of the total copper.

X-Q. 128. Can you make flow sheets for this, just pencil sketches of the Braden, Timber Butte, Anaconda

George A. Chapman.

and El Cobra plant, as last seen and described by you?

A. The Braden, the Timber Butte, Anaconda and El Cobra?

X-Q. 129. Yes, with a description of what comes into it?

A. Yes.

X-Q. 130. Did you do any work on the concentrates and tails on the round table at Anaconda?

A. Not the concentrates, but the tailings.

X-Q. 131. Now, have you named all the oils that you can remember that were used at Anaconda, particularly all the mineral oils? I think I referred to the stove oil and fuel oil.

A. Yes.

X-Q. 132. Any other mineral oils?

A. None that I remember.

X-Q. 133. Have you noticed any relation between the amount of oil and the dilution of the pulp?

A. Certainly.

X-Q. 134. And what has that been, according to your observation?

A. That was very clearly demonstrated when we were doing the work on the round table, the feed compared with the round table tailings. The round table tailings at Anaconda of course contained more water than the round table feed, and naturally the amount of reagents had to be increased.

X-Q. 135. Increased with the greater dilution?

A. Greater dilution of the pulp.

George A. Chapman.

X-Q. 136. And by the term "reagent" you include oil?

A. Oily reagents.

X-Q. 137. Will you state the size to which you ground in both the copper and zinc plants of the Anaconda?

A. Well, the aim at Anaconda in the copper separation was to get a product through 60 mesh, but of course in the beginning of the operation they had considerable trouble with the regrinding section. The source of supply of pebbles for the grinding mill and tube mill was certainly cut off by the shipping troubles on account of the European war and for many months experiments had to be carried out with a substitute on the various ores instead of the pebbles. Does that answer your question?

X-Q. 138. You did not refer to the zinc, did you?

A. Why the zinc plant, most of that work has been done since I left Anaconda.

X-Q. 139. Any of it done while you were there?

A. Why, I could get at records to give you these figures, but I don't recall them quite well now.

X-Q. 140. Have you any idea of what the approximate screen analysis would be of material that was simply ground to go through a 60 mesh? That is, how fine would it be?

A. Well, it all depends on the method of grinding. But assuming an ordinary Hardinge's mill grind—

X-Q. 141. (Interrupting) Is that what they used at Anaconda?

George A. Chapman.

A. Well, all except one section where there was a tube mill installed. I should say between 38 to 42% would pass through a 200 mesh screen.

X-Q. 142. Have you any idea as to how much would go through 100?

A. No, but I can give you absolutely definite figures.

X-Q. 143. Well, now, if you have got them convenient I would like to have them.

A. Certainly.

X-Q. 144. Do you know anything of your own knowledge about the results of the Callow process at Anaconda? By "Callow" I mean the processes using the vessels with the canvas or other porous bottoms, and the injection of air under pressure?

A. Yes, I know that such cells were installed beneath the Minerals Separation standard machines in the mill, and were intended for the retreatment of Minerals Separation concentrates, but we did quite some interesting work and we proved that we actually got a cleaner concentrate by returning the middlings to the Minerals Separation machine instead of sending them to the Callow machine, and the middlings from the Callow machine, being returned to the head of the Minerals Separation flotation machine. The Minerals Separation machine alone produced a grade of concentrates that was more satisfactory to the officials at Anaconda.

X-Q. 145. What grade zinc concentrate does the Minerals Separation machine make at Anaconda? That is, what per cent of zinc?

George A. Chapman.

A. Well, of course that varies considerably, as you know. The Anaconda Company are opening up quite a number of zinc mines, and the ore delivered to Anaconda of course is very patchy, but we have tried to keep the insoluble content of the ore between 5 and 6% and I think that is a general and a fair statement of what this concentrate actually contains.

X-Q. 146. Can't you state it in terms of zinc, what the range of zinc per cent would be?

A. Yes. I would say that that would go between 32 to 40% of zinc.

X-Q. 147. 32 and 40?

A. Yes.

X-Q. 148. Well, can you give any example of the heads? You said it was patchy, but wasn't there some of the ores that you can give us an idea about as to what they ran in zinc?

A. Yes, they have varied between 13—to as high as 17 and 18 and perhaps 19% of zinc on occasions. It is generally maintained at about 15%.

X-Q. 149. Didn't the Anaconda Company have quite a force of engineers working on flotation problems?

A. At what time?

X-Q. 150. Well, at the time they were contemplating its introduction?

A. No. The only gentleman I know that was doing any work at all on the proposition was Mr. Ralph Diamond.

George A. Chapman.

X-Q. 151. No one else on the Anaconda force worked on flotation to your knowledge?

A. Not to my knowledge, and I don't believe there was.

X-Q. 152. About what period of time elapsed between the first test of slimes at Anaconda and the first satisfactory results?

A. Why, possibly two or three weeks; maybe less, but that is again very indefinite. I have a paper by Messrs. Laist & Wiggin, which states it very definitely.

X-Q. 153. Was this Mr. Diamond working on flotation when you came to Anaconda to make your tests?

A. He had, I believe, been doing some work in the laboratories of the Butte & Superior Company.

RE-DIRECT EXAMINATION

BY MR. WILLIAMS:

R-Q. 154. Who is Mr. Laist?

A. Mr. Laist is now general manager of the Washoe Reduction works at Anaconda.

R-Q. 155. And who is Mr. Wiggin?

A. Mr. Wiggin is general superintendent of copper concentration for Montana for the Anaconda Copper Company.

R-Q. 156. These zinc ores of Anaconda—of the Anaconda, in what manner were they treated before flotation was adopted?

A. They were never treated.

R-Q. 157. And why not?

A. Why the ores were of such a complex nature.

George A. Chapman.

R-Q. 158. What was the complexity?

A. Why, the complexity consisted of—chiefly of the other minerals combined with the zinc.

R-Q. 159. That is to say in what form, sulphides?

A. Sulphide form.

R-Q. 160. That is to say, in connection with the zinc sulphides there were other sulphides?

A. Yes.

R-Q. 161. And what was the principal one; what was the principal one of them?

A. Iron pyrite, chiefly.

R-Q. 162. And these concentrates that they recover now, would they be marketable for smelter purposes?

A. They would have to have a good smelter contract to be able to ship less than 35% zinc concentrates to the east.

R-Q. 163. And as a matter of fact, as you said, they are treated by electrolytic processes?

A. Yes.

R-Q. 164. And that gives a different grade of zinc does it not, from the smelter process?

A. It gives the purest zinc that has been known.

R-Q. 165. And that electrolytic treatment is by electricity obtained from what?

A. Water power.

R-Q. 166. So that the whole problem of the treatment of these ores involves the water power for electricity and flotation in the treatment of an ore which would be otherwise untreatable? Is that correct?

George A. Chapman.

A. That is so.

R-Q. 167. Now, you gave an example of an increase of frothing agent accompanied ~~accomplished~~ by an increase in the dilution of the pulp. Did that frothing agent contain soluble constituents?

A. It did.

R-Q. 168. Can you recall any example where, employing an insoluble frothing agent you found that the increase in the dilution of the pulp required an increase in the amount of the soluble frothing agent?

A. No, I can not.

R-Q. 169. Now, in the various plants that you have referred to in your testimony were there any Minerals Separation sub-aeration machines?

A. Yes. I have seen one installed at the Braden Copper Company and at the Inspiration Copper Company. I have seen machines of that type in the Dutch Sweeney mine in California, Utah Leasing Company, Utah, and we did have one in experimental practice at Anaconda.

R-Q. 170. What sort of an ore is that in the Dutch Sweeney?

A. Pyritic gold ore, assaying between three and four dollars per ton.

R-Q. 171. That is the ore?

A. That is the ore, yes.

R-Q. 172. Do you know what the concentrate was?

A. The concentrate would vary from thirty to forty dollars per ton, but nearer $40.00 per ton.

R-Q. 173. Are there any other examples within your experience of the treatment of gold ores?

George A. Chapman.

A. Yes, in the Cripple Creek district.

R-Q. 174. And silver ores?

A. No, not silver ores alone.

R-Q. 176. And what are the other varieties of ores to which you have applied or seen applied the froth flotation process?

A. Why, the lead ores of the Missouri district—I think that is about the only other variety I have seen.

R-Q. 177. So it is zinc ores, lead ores, copper ores and gold ores and some of these zinc and lead ores contain precious minerals?

A. Precious minerals.

R-Q. 178. Gold and silver?

A. Gold and Silver, yes, sir.

R-Q. 179. Now, in all of these processes that you have described is there agitation, aeration with the use of amounts of frothing agent of six or seven pounds to the ton of ore or less, and froth recovery of the mineral?

A. There is.

MR. WILLIAMS: That is all.

RE-CROSS EXAMINATION

BY MR. SCOTT:

RX-Q. 180. Have you any information one way or the other regarding the relation between insoluble oil and solubles?

A. Yes, I can give the instances at Braden where we thinned out the pulp considerably and we were not

George A. Chapman.

able to decrease the amount of fuel oil that was used but we were able to decrease the amount of European wood tar oil. Later on we did effect an economy of the fuel oil by atomizing the oil before we added it to the flotation machine; but the economy in the fuel oil was proved absolutely not to have anything to do with the thickness of pulp.

RX-Q. 181. Have you any compilation of figures upon which you can base such a conclusion?

A. I base that on memory now. I know they are absolutely correct.

RX-Q. 182. You never made a compilation of figures and studied the results, did you?

A. Never.

RX-Q. 183. When you went to the Anaconda Company, were you shown the reports and figures compiled by Mr. Diamond in his investigation of flotation?

A. I don't recollect that, Mr. Scott.

MR. SCOTT: That is all.

RX-Q. 184. MR. WILLIAMS: Did you ever draw a curve on the subject about which you have just been cross examined?

A. No.

RX-Q. 185. MR. SCOTT: Mr. Chapman, did you talk to Diamond about his work in flotation when you came to Anaconda?

A. Yes, we had a general conversation, but the extent of our conversation was this that Diamond said that he had been doing flotation tests, and beyond that

I had no knowledge of the results he had been getting.

X-Q. 186. Didn't he describe to you how he had proceeded and what he had done?

A. He told me that he had been using the slide machine in some tests.

X-Q. 187. And did Mr. Diamond tell you where he had conducted his investigation?

MR. WILLIAMS: I think that what Mr. Diamond told Mr. Chapman is incompetent.

THE COURT: I will sustain the objection.

X-Q. 188. MR. SCOTT: Do you know where Mr. Diamond conducted his investigations?

A. He told me that he conducted them in the laboratory of the Butte & Superior Copper Company.

(WITNESS EXCUSED).

MAXWELL W. ATWATER, Recalled as a witness in behalf of the plaintiff in rebuttal, testified as follows:

DIRECT EXAMINATION

BY MR. WILLIAMS:

Q. 1. You have heretofore testified as a witness at this trial, Mr. Atwater?

A. I have.

Q. 2. Your name has appeared in the list of licensees of Minerals Separation, Limited, and Minerals Separation, North American Corporation; are you such a licensee?

Maxwell W. Atwater.

A. I am such a licensee.

Q. 3. And have you conducted operations under that license?

A. I have conducted such operations.

Q. 4. When did those operations commence?

A. July, 1914.

Q. 5. What material was it that you treated?

A. At that time, zinc tailings.

Q. 6. And where had those zinc tailings come from?

A. They were left over from the operation of the Butte & Superior Copper Company in the concentrator at Basin belonging to the Basin Reduction Company.

Q. 7. And with those operations of the Butte & Superior Copper Company at Basin, Montana, as the result of which these tailings were produced, were you or were not in charge of those operations?

A. I was the Butte & Superior Company's general superintendent at that time.

Q. 8. Over how long a period have those operations extended?

A. A little over two years.

Q. 9. When did they stop?

A. In May, 1912.

Q. 10. And do they or do they not represent all the operations of the Butte & Superior Company with water concentration alone?

A. Almost entirely; there was some flotation conducted there.

Q. 11. During 1911?

A. Yes, sir.

Q. 12. But except for that it was all water concentration?

A. Entirely, yes.

Q. 13. And did you mention the number of tons of material treated in those operations?

A. Yes; we milled 300,000 tons of ore at Basin.

Q. 14. As the result of the milling by water-concentration of 300,000 tons of ore, what quantity of tailings were actually produced?

MR. KREMER: We object to this as incompetent, irrelevant and immaterial, and not related to any of the issues in this case. I don't know whether we have a right, but I think we should be allowed to ask what is the purpose of this testimony. I don't want to insist on an objection if there is any reason.

THE COURT: What is the object of this testimony?

MR. WILLIAMS: The object of this testimony is to show that before the Butte & Superior Copper Company adopted flotation, their operations produced a great mass of tailings, and that this witness took those tailings, or what was left of them after they had been on the dump for years, and by the use of this process in suit, made a fortune out of it. I think that is relevant.

MR. KREMER: That does not in any way refer to infringement.

Maxwell W. Atwater.

MR. WILLIAMS: It refers to utility; it is proof of utility.

THE COURT: It shows utility of the process and the extent to which it has been used. Objection overruled.

Defendant excepted.

A. There were left some fifty or sixty thousand tons of tailings on the dump at Basin. I haven't in mind right now how many actual tons of tailings were produced.

Q. 15. But all that you found there were from fifty to sixty thousand tons?

A. That's about all, yes.

Q. 16. And you know, do you, or do you not, that some of those tailings had been removed, or had otherwise gone?

A. Certainly; I know that the greater part of these tailings were gone; they had gone down the river and had been hauled away.

Q. 17. Now, what was the zinc content of these fifty or sixty thousand tons of tailings?

A. They averaged about 14 per cent zinc.

Q. 18. How long had they been on the dump before you commenced to operate on the dump?

A. Well, the mill shut down in May, 1912, and we commenced operating in June, 1914, that is over two years at least.

Q. 19. With this material what was your method of treatment?

A. Regrinding and flotation with an M. S. Standard machine.

Q. 20. Was there a cleaner machine that you used with it?

A. We used a sub-aeration cleaner machine to clean the concentrate that was made on the M. S. Standard flotation machine.

Q. 21. And that sub-aeration cleaner machine, that was not a Minerals Separation machine, was it?

A. No, it was not. We call those the Fagergren-Green Cones.

Q. 22. And that was a type of machine in which there was sub-aeration. In what manner was the sub-aeration carried on?

A. Air was introduced through these cones through a porous brick at the bottom of the cone.

Q. 23. Above that porous brick was there anything in the nature of an agitator?

A. Yes, we had a slow moving agitator above the porous brick.

Q. 24. That was the cleaner machine?

A. That was the cleaner machine.

Q. 25. Now, what sort of results did you get in this process as you carried it on in grade of concentrate?

A. We made a pretty good grade of concentrate there. Our average grade in treating those dumps was better than 54 per cent. I remember six months when we ran steady over 57 per cent.

Q. 26. And in regard to the recovery, what percentage of recovery or extraction?

Maxwell W. Atwater.

A. Ninety per cent of recovery, and perhaps a little better.

Q. 27. What frothing agents did you use?

A. We first used oleic acid and sulphuric acid. Later we used on the zinc pine oil, crude turpentine and sulphuric acid.

Q. 28. Did you or did you not use heat?

A. We used heat always, yes.

Q. 29. In what proportion did you use the oleic acid, pine oil and turpentine generally?

A. When we used oleic acid we ran about six pounds of oleic acid to the ton of ore and if I remember rightly from two to four pounds of sulphuric acid. When we used turpentine and pine oils we use between one and two pounds of oil either mixed together or separate, and as high as fifteen pounds of acid. At times when the tailings were dirty we used more acid than fifteen pounds to the ton.

Q. 30. What has become of that dump; is any of it left?

A. No, there is none of it left.

Q. 31. You have treated it all?

A. We have treated it all.

Q. 32. By flotation?

A. By flotation.

Q. 33. Under the Minerals Separation license?

A. Yes, sir.

Q. 34. And the metal was all recovered in what form in the process?

A. In the form of concentrate.

Q. 35. And in the machines it appeared as what?

A. As a froth.

Q. 36. What was the profit of that operation per ton of concentrate produced, taking into account what you paid as royalty and what it cost you to treat the dump?

A. Well, we cleared about $45.00 a ton for the concentrate over all expenses.

WHEREUPON an adjournment was taken until Tuesday, May 8th, 1917, at 10:00 A. M.

Tuesday, May 8th, 1917, 10:00 A. M.

MAXWELL W. ATWATER, resumed the stand for further

DIRECT EXAMINATION,

BY MR. WILLIAMS:

Q. 37. You have described, Mr. Atwater, your operations of changing the dumps of the Butte & Supperior Company into concentrates. What other operations have you carried on employing the flotation process under license from the Minerals Separation, Limited?

A. After finishing up the zinc dumps at Basin we commenced treating the old tailings from the Heinze operations in Basin prior to 1906.

Q. 38. With what kind of ore?

P. 4133, L. 25, insert " Three pounds of the mixture of oil to the ton of ore," after " ore "

Maxwell W. Atwater.

A. They were Butte ores, copper ores.

Q. 39. And what is the copper content of the dump?

A. Averages about 1.25 per cent copper.

Q. 40. And are they the dumps of wet concentration operations?

A. Yes, sir.

Q. 41. Are you working them now?

A. Yes, we are working those now.

Q. 42. In treating this copper material by the froth flotation process, what is your procedure as to reagents? The same or different from what it was with zinc?

A. It is about the same. We use a different mixture of oils. We are running on what we call an acid circuit, the same as with the zinc.

Q. 43. That is you are using sulphuric acid?

A. Yes, sir.

Q. 44. Are you using heat?

A. We are using heat, yes.

Q. 45. And what oils are you using and in what proportion?

A. We are using a mixture, pine oil, tar oil, hardwood creosote, sludge acid and some kerosene; and in quantities of about three pounds to the ton of ore. The acid we use is about eight pounds per ton of ore.

Q. 46. Well, now, in this mixture you use how much kerosene to the ton of ore?

A. Oh, less than a quarter of a pound of kerosene to a ton of ore.

Q. 47. You said tar. What kind of tar?

Maxwell W. Atwater.

A. Tar oil I said.

Q. 48. About how much of that to the ton of ore?

A. Maybe half a pound to the ton of ore.

Q. 49. What is the principal component of the mixture?

A. What is known as Cleveland Cliff creosote; it is a hardwood creosote.

Q. 50. What kind of recovery are you making?

A. Very close to ninety per cent, sometimes above that.

Q. 51. And what grade of concentrates are you producing?

A. The concentrate runs from—our concentrates will average nine per cent copper.

Q. 52. What is the grade of the concentrate in the copper? That is to say, how much of the concentrate in the copper?

A. You mean what is the sulphide content?

Q. 53. No, what is the copper content of the concentrate?

A. About nine per cent copper.

Q. 54. And that concentrate is sent by you to a smelter?

A. Yes.

Q. 55. And it is presumably profitable of course; of course it is a profitable concentrate?

A. We are making money on the operation, yes, sir.

Q. 56. And are there other materials present besides copper in the concentrate?

Maxwell W. Atwater.

A. Yes, about an ounce of silver to the unit of copper. That would be nine per cent copper and nine ounces of silver in a ton of concentrate.

Q. 57. Then are there any other metals that are not counted as valuable in the concentrate?

A. Yes, there is always a little iron present in the concentrate that they don't pay for.

Q. 58. Have you made a computation based upon the operations of the Butte & Superior Copper Company in the treatment of these 300,000 tons of ore at Basin, practically wholly by water concentration, for the purpose of determining what would have been the added profits of the Butte & Superior Copper Company if they had employed, instead of water concentration, the process of froth flotation, as you carried it out later; have you made such a computation?

A. Yes, I have.

Q. 59. And what was the conclusion as to that computation?

MR. KREMER: We object to this for the reason that it is incompetent, irrelevant and immaterial, and has gone beyond the scope of what counsel announced that this character of examination would precede, for the purpose of showing utility. This is not an action in accounting, and we object to this testimony for that reason. We are not prepared to meet a matter of that sort; it is not within the issues.

THE COURT: I can not see that it has very much value, there are so many factors which enter in, the price of metals and all those things. What is the basis for this computation?

Maxwell W. Atwater.

Q. 60. This computation was made, was it not, based on the prices of metals at the time that this ore was milled?

A. Yes, that was the basis of my computation.

Q. 61. What familiarity have you with the prices of metals and the value of concentrates in zinc particularly?

A. Well, of course I knew the terms of the contract with the Butte & Superior, and I have my own contracts with the smelter, and I have seen other contracts between smelters and the operators.

Q. 62. Isn't it a fact that you are familiar with all the elements that go to determine the value of this concentrate made at Basin, Montana?

MR. KREMER: That is objected to as calling for a conclusion of the witness. It is very apparent that there must be a number of assumptions before any computation can be made.

THE COURT: Let us see; this witness was in charge of operations at the time; and he says he knows the contract and the prices.

MR. KREMER: I don't think I made myself clear, your honor. There must be an assumption. As I understand the question it was the difference between the profits that would have accrued with flotation and those which would have accrued made by concentration.

MR. WILLIAMS: Between those which did accrue.

THE COURT: I think he can answer. It may not

Maxwell W. Atwater.

be much value, but it may in a very practical fashion show the utility of the process.

MR. KREMER: The only thing that I have in mind is meeting this matter. If we go into that whole matter it will take time.

THE COURT: Oh, no: the objection will be overruled.

Defendant excepts.

Q. 63. Now, Mr. Atwater, if the Butte & Superior Copper Company had used froth flotation instead of water concentration, what sum of money would have been added to their profits or their net returns?

MR. KREMER: In addition to the objection last interposed I desire to interpose the further objection that it is not proper rebuttal. If it had been their purpose to show utility of the process, it was a part of their case in chief, if it has any place in the case at all.

THE COURT: No. All they had to show in chief, was the patent, as a matter of fact, and there would be a presumption of its validity until you attacked it. Perhaps it is not so much now a question of utility as of anticipation. In the Hyde case it was partly a question of utility as well. The objection will be overruled.

Defendant excepted.

MR. KREMER: Over what period of time does the question cover, Mr. Williams?

MR. WILLIAMS: That has all been covered; the treatment of these 300,000 tons of ore.

MR. KREMER: During the time that Mr. Atwater was there?

MR. WILLIAMS: Mr. Atwater was there all the time; that has appeared.

THE COURT: Answer the question.

A. Over a million dollars.

CROSS EXAMINATION

BY MR. KREMER:

X-Q. 64. Over what period of time, Mr. Atwater, did you make this estimate?

A. The period of time the Butte & Superior was milling its ore at Basin, 1910, 1911 and about a month or two of 1912.

X-Q. 65. How many flotation operations were being conducted in and about this vicinity at that time?

A. Only one that I know of.

X-Q. 66. Where was that?

A. At Basin.

X-Q. 67. The one that you were conducting for the Butte & Superior?

A. Yes, sir.

X-Q. 68. You were the general superintendent?

A. Yes.

X-Q. 69. And you had charge of their milling department?

A. Yes.

X-Q. 70. Had the dictation of policy as to what processes would be adopted?

A. Yes.

Maxwell W. Atwater.

X-Q. 71. And why didn't you recommend the adoption of flotation at an earlier date?

A. Because I hadn't heard of flotation at an earlier date.

X-Q. 72. It was not in general usage was it, Mr. Atwater?

A. No.

X-Q. 73. You were one of the very first men to install flotation upon a commercial basis or an operating basis in the United States, were you not?

A. I believe so.

X-Q. 74. As a matter of fact you were the first, were you not?

A. Well, I don't know that I was the first

X-Q. 75. You were very close to the first?

A. Yes.

X-Q. 76. And now when you say that if Butte & Superior had adopted flotation instead of proceeding with wet concentration methods at Basin they would have made over a million dollars, by that you mean that if they had adopted the use of flotation prior to the time that they did they would have made a million dollars? Is that what you mean?

A. I mean that if they had started using flotation when they started to concentrate the ores at Basin, if they had used flotation instead of wet concentration from the start of their operations at Basin until they finished, that their profits would have been increased a million dollars.

X-Q. 77. And they started operations at Basin in 1910?

Maxwell W. Atwater.

A. January, 1910.

X-Q. 78. Of course, Mr. Atwater, in making your computation, you have estimated all of the costs attendant upon the milling operations, haven't you?

A. Necessarily so.

X-Q. 79. Transportation and all?

A. Yes.

X-Q. 80. You have made no allowance in these figures for the fact that in 1910 the ores from the mine would have to be hauled by wagon team down to the spur, the railroad spur in Meaderville and then be loaded on to cars and transported to Basin on local freight rates, have you?

A. I didn't have to change the mining figures and the ore ~~loading~~ hauling figures at all in that computation.

X-Q. 81. Well, I asked you if you figured in the transportation in your excess profits and I thought you said yes.

A. Why, I took the mining costs as they were in figuring these.

X-Q. 82. Well, did you charge your transportation costs to milling or to mining? You certainly didn't charge your transportation cost to mining?

A. Certainly not. I charged them to transportation.

X-Q. 83. And in estimating the mill costs, did you figure in transportation as an element?

A. Certainly.

X-Q. 84. You did?

A. Certainly.

Maxwell W. Atwater.

X-Q. 85. That cost was very high, wasn't it, Mr. Atwater?

A. Yes, indeed.

X-Q. 86. So that I may understand you, Mr. Atwater, you mean that if the Butte & Superior had adopted flotation in 1910 and continued flotation up to the time that it actually did adopt flotation, that its profits would have resulted in a million dollars in excess of what they were?

A. I mean that but with the proviso that while operating flotation they had done as well in recoveries as we did—as, we will say, I did at Basin afterwards.

X-Q. 87. How many years afterwards, Mr. Atwater?

A. The milling operations I have just finished testifying about.

X-Q. 88. That is several years ago?

A. That started in 1914, yes.

X-Q. 89. There was great advancement, was there not, in the results obtained by the use of flotation during that period?

A. There was a great advancement in my own knowledge of flotation.

X-Q. 90. That is to say that you were enabled by the experience acquired in the use of the flotation process and by the application of mechanical and engineering processes to effect a greater degree of recovery and to make a higher grade of concentrate? Isn't that true?

A. Yes, that is true.

Maxwell W. Atwater.

X-Q. 91. Now, by the way of comparison, Mr. Atwater, would you kindly state the difference between the recovery upon the first commercial operations that you conducted and the recovery that you are effecting in your own plant at Basin? Do I make myself clear?

A. Not quite.

X-Q. 92. Assuming that you are making a recovery of 80 per cent of the mineral content while conducting your first commercial operation with flotation, what would have been the relative recovery, or the comparative recovery with the operation that you conducted at Basin? Would it have been higher or lower?

A. I don't understand you now.

X-Q. 93. Were you making a greater recovery then at Basin—a greater recovery at Basin than you were making when you were conducting your first commercial operations?

A. Yes, a greater recovery.

X-Q. 94. How much greater? That is what I want to get at.

A. Why, we are making.

X-Q. 95. Approximately?

A. Ten or fifteen per cent greater.

X-Q. 96. Then if under the assumption that I have made, if your recovery upon your first commercial operation had been ~~60,~~ 80 why the recovery upon the more refined operation would be 90?

A. Yes, take it that way.

X-Q. 97. What is that due to, Mr. Atwater? The

Maxwell W. Atwater.

advancements made in the operation, the knowledge gained and the experience that has been derived from the constant use of the flotation process, studying the factors?

A. I think it was mostly due to following the advice of Minerals Separation experts.

X-Q. 98. Whose advice did you follow?

A. T. M. Owens' advice.

X-Q. 99. Was there any marked change in the operations since you have known them?

A. Yes, there was quite a different process.

X-Q. 100. What was that change?

A. You mean what was the change that Owen advised me to put in?

X-Q. 101. Yes.

A. Stop the use of oleic acid, change to pine oils, reduce the amount of oil considerably and increase the amount of acid.

X-Q. 102. Well, how much did you reduce your oil?

A. Reduced our oil four pounds a ton, when we changed from oleic to pine oils.

X-Q. 103. That was due entirely to the character of the oil—that is the character of the oil?

A. I think so, yes. I do not think we could have used six pounds of pine oil successfully even the way we were working then.

X-Q. 104. Did you ever try it?

A. I have seen the machine over oiled when it might contain six pounds of pine oil.

Maxwell W. Atwater.

X-Q. 105. You don't know what it did contain?

A. No, we didn't measure it.

X-Q. 106. How about machines?

A. When I started our flotation operations at Basin we purchased what is known as standard Minerals Separation machine, and we didn't change that when we changed the oils and acids.

X-Q. 107. And you are still using that so-called standard Minerals Separation machine?

A. Yes, sir.

X-Q. 108. Did Owen recommend any other machine?

A. He did not.

X-Q. 109. Do you recognize any distinction or difference between the standard Minerals Separation flotation machine and a sub-aerated machine?

A. Why certainly I recognize a difference.

X-Q. 110. Aren't you using a sub-aerated machine?

A. We are using one now, yes.

X-Q. 111. Upon whose advice did you adopt that?

A. That was put in on our own—

X-Q. 112. And you have not entirely confined your operations to the direction and advice of Mr. Owen or the Minerals Separation, have you?

A. Not entirely, no.

X-Q. 113. And aside from advising you to change the amount of oil and to change from the use of oleic acid to pine oil, what other changes did Mr. Owen recommend to you?

P. 4145, L. 23, insert "Did you know that before Mr. Owen told you. A." after "119."

Maxwell W. Atwater.

A. Why, he recommended—he worked in the plant for quite a while and during that time he experimented in many ways with dilutions of feed, with fineness of grinding, with various treatments.

X-Q. 114. Just confine yourself to the recommendations that he made, Mr. Atwater, as to the things that you adopted. I asked you what he recommended?

A. Why, there were many small mechanical details in the mill. The principal recommendations that he made are those that I have already mentioned.

X-Q. 115. Well, at that time had you not information that pine oil was being used elsewhere?

A. Yes.

X-Q. 116. Where was it being used, if you know?

A. I think they were using pine oil at that time at the Timber Butte mill in Butte.

X-Q. 117. What time was that?

A. This was in 1914.

X-Q. 118. Don't you know that they were using pine oil at the Butte & Superior at that time?

A. I was about to add at the Butte & Superior?

X-Q. 119. I believe I did; I don't know whether I knew it before; we were all changing our oils—the various flotation plants were changing their oils pretty rapidly at that time, experimenting.

X-Q. 120. Then Mr. Owen did not tell you anything that was not generally known, did he; that is, about the desirability of changing from oleic acid to pine oil?

A. No, I suppose not.

X-Q. 121. Now, the, what did he tell you that was

Maxwell W. Atwater.

not generally known, or which you did not know before, in connection with the process?

A. I think the value of his services to me was mainly in his definite knowledge and his definite statements and recommendation in putting into operation—

X-Q. 122. I don't like to interrupt you, because we usually get along faster if I don't; but please answer the question; what did he tell you that you did not know and that was not generally known?

A. I am not responsible for general knowledge. If you ask me what I know I will tell you.

X-Q. 123. What did he tell you that you did not know then?

A. He told me to use less oil, and the kind of oil to use, and more acid and more heat, and I did not know that those were the proper things to do until he told me so.

X-Q. 124. You had used heat before?

A. We had used heat before.

X-Q. 125. What temperature?

A. We ran the machine at about 100° F., I believe.

X-Q. 126. The centigrade scale has been used throughout the testimony, so would you reduce that to degrees centigrade?

A. Yes; about 40° C.

X-Q. 127. Had you ever operated before at 40° C.?

A. We were operating then at 40. He raised the temperature above 40.

X-Q. 128. To what?

Maxwell W. Atwater.

A. 50 or 55° C.

X-Q. 129. Had you ever operated before at 55° C.?

A. Probably; certainly not steadily.

X-Q. 130. Didn't you operate the Butte & Superior plant at 55 to 60° C.?

A. No, I don't think we operated the Butte & Superior plant as high as we operated the Basin plant which we put in.

X-Q. 131. Well, Mr. Atwater, from your experience in flotation, do you or do you not subscribe to this general statement, that every ore—and in that I embrace tailings of course.

A. Yes.

X-Q. 132. Every one furnishes its own flotation problem?

A. Yes, I subscribe to that general statement.

X-Q. 133. Then the changes and variations which are made in operation are largely due to the character of the product being treated; is that not true?

A. That is true.

X-Q. 134. So, where a greater degree of heat, a larger amount of oil, a larger amount of acid, if acid is used—a greater degree of agitation, a greater degree of dilution, all are factors that enter into flotation operations as you endeavored to apply them to different products, isn't that true?

A. Yes, that is true.

X-Q. 135. What is the percentage of iron and insoluble in your present concentrates. your copper concentrate; I only mean approximately, of course.

Maxwell W. Atwater.

A. The iron runs about 10% and the insoluble runs 15 or 20%; that will do for an approximation.

X-Q. 136. What is the per cent of iron?

A. About 10% I said, and 15 or 20% insoluble.

X-Q. 137. What is the balance of your hundred per cent?

A. Well, we have the copper and the silver.

X-Q. 138. You have 9% copper?

A. Well, add it up there; there is 9% copper; add the silver to that, and then add the 10% of iron, and we have a little lead—1% of lead, no, there is very little lead. The rest would be insoluble, or very nearly so; it would make about 40, wouldn't it?

X-Q. 139. Do you desire now to say that your insoluble is 45 rather than 15?

A. Yes, I think that is closer to it.

X-Q. 140. Now, these copper concentrates that were made from the tailings deposited during the old Heinze operations, at Basin reduction works, extending over a period of a number of years prior to 1910?

A. Yes.

X-Q. 141. What is your ratio of concentration in the treating of those tailings?

A. About eight or nine tons of ore into one of concentrate.

X-Q. 142. Running 9% copper, the concentrate, of course?

A. Yes.

X-Q. 143. What is the copper assay of the heads into your flotation machine?

P. 4149, After L. 2, insert " x-Q. 144. And the tails ? "

Maxwell W. Atwater.

A. About 1.25% copper.

A. The tails run around .2 when the machine is operating well.

X-Q. 145. What does it run when it is not operating well?

A. About .4 or .5.

X-Q. 146. What else do you find in those tailings; what other metal?

A. Silver, and a little bit of gold; silver is the only thing that amounts to anything in value.

X-Q. 147. You stated that you were using a sub-aeration machine; I more properly should have asked this a while ago when we were discussing your plant. Was that sub-aeration machine in existence in 1910 or was there such a machine in existence in 1910—to your knowledge, of course?

A. Not to my knowledge.

X-Q. 148. Now, Mr. Atwater, regarding this estimate that you made of a million dollars excess profits between the time that the Basin mill started on wet concentration and the time when flotation was adopted, what recovery do you assume in your wet concentration upon the Butte & Superior ore?

A. When I made that computation I believe I used 55% recovery; between 55 and 60% I must have used.

X-Q. 149. You would not assume 65 or 70?

A. I did not assume 65 to 75, no.

X-Q. 150. Would you do that from your knowledge of that ore?

A. I would not.

X-Q. 151. When you say you would not assume 65 to 70% recovery, have you in mind the plant in which you were operating?

A. Yes.

X-Q. 152. Is that one of the factors?

A. Yes, indeed.

X-Q. 153. By that you mean that the Basin plant was not well adapted to milling—to successful milling, do you not?

A. Yes.

X-Q. 154. Well, how would that have affected the increased recovery in flotation, if the Basin plant was wasteful? How would that affect the additional recovery by flotation?

A. Well, the best we ever did in the way of recoveries at the Basin plant by wet concentration for a month's average, was 60% I believe; 60 or very close to that.

A. Yes.

X-Q. 156. The mill was all out of alignment?

A. Yes.

X-Q. 157. The launders were right against the ground, underneath the floors, causing a constant overflow and flooding of the mill, was it not?

A. The mill was in very bad condition.

X-Q. 158. The elevators were in very bad condition, constantly breaking and overflowing and not performing their functions, were they not?

A. That is true.

X-Q. 159. It was impossible to place—I wouldn't

P. 4150, After L. 19, insert "x-Q. 155. You know why you did not make a better recovery?"

Maxwell W. Atwater.

say it was impossible, but it was practically impossible to place your tables upon a level base for successful table operations, was it not?

A. Yes.

X-Q. 160. The mill was sloping down hill, was it not?

A. Yes, it was actively sloping down hill.

X-Q. 161. It was a very bad mill, was it not?

A. A very bad mill.

X-Q. 162. Do you think that had anything to do with the fact that there was 14 per cent zinc contained in the tailings?

A. Yes.

X-Q. 163. Now in addition to the tailings that you found there as a result of Butte & Superior operations were there any other tailings deposited there?

A. No.

X-Q. 164. Don't you know, Mr. Atwater, that there was the—that during the Heinze operations that a large tonnage of zinc ore from the La France mine or the Lexington mine of the La France Company had been milled in that plant at Basin?

A. I know that they had a mill running there of a few hundred tons—I would call it a few hundred tons, not a large tonnage.

X-Q. 165. You state that as a matter of knowledge or as a matter of impression, Mr. Atwater—I better ask you this way: Do you know whether or not the Basin Reduction Company or the La France Company operated that mill upon Lexington ores over a con-

siderable period of time constantly, meaning many months.

A. You mean while we were operating there?

X-Q. 166. No, I mean before?

A. No, I do not know.

X-Q. 167. Now, during the time that the Butte & Superior was operating at the Basin mill or at least during a part of the time the Butte & Superior was operating at the Basin mill, the mill was divided into two units, was it not?

A. Yes.

X-Q. 168. Butte & Superior using one unit and the La France or Basin Reduction Company using the other?

A. The La France Copper Company reserved the right to use the other half.

X-Q. 169. And they did do that, did they not?

A. For a short time.

X-Q. 170. Can you tell how long a time?

A. No, I can't tell you that.

X-Q. 171. Can you tell us what tonnage of zinc ore from the Lexington mine they treated there?

A. No, I can't tell you that. I was under the impression it was a few hundred tons while we were there.

X-Q. 172. Then I will ask you one general question to cover all of that: Can you tell us the recovery that they made; the percentage of zinc in their tailings; or approximately the number of tons of tailings deposited by the La France operations?

Maxwell W. Atwater.

A. I cannot.

X-Q. 173. Or anyone of those facts?

A. None of them.

X-Q. 174. Now, in estimating the profits which you say might have accrued to the Butte & Superior, what allowance for interest and amortization on the original investment did you make?

A. I made no allowance whatever.

X-Q. 175. How did you calculate the amortization on the hypothetical flotation plant?

A. I had the figures, costs and returns, of expenses that went to the Butte & Superior operations in Butte and Basin. I had those at the time and I added to them the cost of treating the tailings, which I had treated myself there. I knew the cost per ton of treating those tailings. I added ~~the I added~~ to the concentrate returns ~~reports~~ the extra recovery they would have made, and as I remember these computations, the difference was over a million dollars.

X-Q. 176. Now, Mr. Atwater, can you furnish us with a table which you used?

A. What table?

X-Q. 177. The table that you used in getting up these figures? A table showing all of the facts that you considered in arriving at this one million dollar increased profits?

A. The table of costs for the Butte & Superior operations or the table of my computations?

X-Q. 178. The table of your computation?

A. No, I cannot. I made those computations some years ago.

X-Q. 179. Well, surely, Mr. Atwater—

A. (Interrupting.) I haven't got those papers.

X-Q. 180. Can't you do it for us now; can't you make up a table?

A. While I am sitting here?

X-Q. 181. Oh, no, no, not while you sit there.

A. Why, certainly, yes.

X-Q. 182. When will you do that?

A. I will do that as soon as I am able, I will today or tomorrow.

X-Q. 183. Will you do that and furnish it to us?

A. With pleasure.

X-Q. 184. Did you add to the cost of concentrating equipments and operations to keep the tailings out of the creek at Basin? Do you recall that now offhand, whether you did or not?

A. Oh, no, I didn't add that. There was no cost to that.

X-Q. 185. Did you add the cost of installing—of installation for finer grinding?

A. Certainly.

X-Q. 186. You did?

A. Certainly.

X-Q. 187. Finer grinding would have been necessary?

A. Yes.

X-Q. 188. How many mills did you allow for?

A. I didn't allow for any number of mills. I mere-

Maxwell W. Atwater.

ly took the cost of our own operations at Basin. By our own operations, I mean the operations in our present flotation plant.

X-Q. 189. All of these things of course that you took into consideration will be shown upon the table that you are going to furnish us, isn't that true?

A. I will show you the way I arrive at my figures, at my results.

X-Q. 190. Now, practically all of this—what proportion I will ask you of the fifty to sixty thousand tons of tailings were produced before flotation was installed at Basin, if you know, Mr. Atwater?

A. You mean before we put the Hyde plant in at Basin?

X-Q. 191. Before Mr. Hyde put the Hyde plant in at Basin, yes.

A. About half of that amount—I am guessing at that; I can't tell it accurately without the record.

X-Q. 192. Mr. Atwater, do you remember a visit made by Mr. Dosenbach and Mr. Wickes to your mill just after you had started operations?

MR. WILLIAMS: Unless the intent of the testimony is to in some way bear upon the direct examination, it seems to me that that is unwarranted.

MR. KREMER: It is or I wouldn't have asked it.

THE COURT: We will see what he comes to.

X-Q. 193. MR. KREMER: Do you know?

A. Yes, I remember a visit by Mr. Dosenbach and Mr. Wickes.

X-Q. 194. After you had been operating a couple of months approximately?

Maxwell W. Atwater.

A. Yes, I think so.

X-Q. 195. You were using six to ten pounds of oleic acid then, were you not?

A. We were using all of six pounds, yes. We might have been using ten pounds.

X-Q. 196. And Mr. Owen visited your plant at that time?

A. I think later.

X-Q. 197. After that?

A. I think later.

X-Q. 198. Didn't they tell you at that time to use pine oil with the oleic acid.

A. I don't remember their telling me to use pine oil with oleic acid, no.

X-Q. 199. Do you remember telling anyone at your plant?

A. I do not, no. I don't remember that.

X-Q. 200. Was it communicated to you that they had told any one of your employes?

A. I do not remember.

X-Q. 201. What was the circumstances if any of the comment about pine oil during that visit?

A. I know of no comment on pine oil during that visit.

X-Q. 202. And will you state that they did not tell you to use pine oil with the oleic acid?

A. I will not state so.

X-Q. 203. You will only say that you do not remember?

A. That is all I can say.

Maxwell W. Atwater.

X-Q. 204. You certainly would have remembered it, Mr. Atwater, would you not?

A. If they told me so then I don't remember, Mr. Kremer.

X-Q. 205. All right. Mr. Atwater, did you ever see the flotation process practiced in an operation provided with three spitzkastens, such as is shown by the diagram accompanying the patent in suit, 835,120? Did you, Mr. Atwater?

A. I don't remember such a machine.

X-Q. 206. Being as interested as you are in flotation, you probably would have remembered if you had ever seen it, would you not?

A. I think if I saw a machine like that running and treating ores that I would remember it, yes.

X-Q. 207. Did you ever see one that was not running and treating ores?

A. You mean a full sized machine built to treat commercial ores?

X-Q. 208. Yes.

A. I think I would remember having seen that machine.

X-Q. 209. But you never did?

A. No.

X-Q. 210. Did you ever see a flotation process practiced with up currents of water in the spitzkasten as shown in patent 835,120?

A. You are referring to this machine? I haven't read the description of it. It is rather hard to read some of these pictures.

X-Q. 211. Can't you read the picture?

A. It shows no current.

X-Q. 212. What?

A. You mean there are up currents of water designated here?

X-Q. 213. What are these?

A. I don't remember seeing such a machine with up currents of water, no.

X-Q. 214. You would remember, would you not, if you had seen it?

A. I don't know.

X-Q. 215. Have you ever seen the flotation plant practiced with the cone Gabbett?

A. On a commercial scale?

X-Q. 216. Yes.

A. No.

X-Q. 217. Have you seen it in experiments performed?

A. Yes.

X-Q. 218. In the court room and in laboratories?

A. Yes.

X-Q. 219. Have you ever seen the flotation process practiced in an apparatus in which the pulp after agitation flowed over an open apron such as is shown by the diagram accompanying patent, 835,120?

A. No, I never saw any operation carried on with that machine.

X-Q. 220. Do you think it practicable to use such a machine as I have described, in commercial operations?

A. Why, I think it is practicable, yes.

Maxwell W. Atwater.

X-Q. 221. Why haven't you done it?

A. Perhaps I never thought of doing it.

X-Q. 222. You have seen that picture many times, haven't you?

A. I never studied that picture.

MR. KREMER: That is all.

RE-DIRECT EXAMINATION.

BY MR. WILLIAMS:

R-Q. 223. You have mentioned Mr. T. M. Owen?

A. Yes.

R-Q. 224. What was his position in connection with Minerals Separation Limited?

A. He was one of their field experts at that time he made the recommendation I spoke about.

R-Q. 225. And was he sent to you by Minerals Separation?

A. Yes, he was.

R-Q. 226. I didn't ask you the extent of the dump of the Heinze copper dumps that you are now treating. What was the amount of these dumps at the time you started operations?

A. Between—about sixty thousand tons, maybe eighty thousand tons. They are very difficult to measure as they lie.

R-Q. 227. There was something said about some other dumps—you live at Basin, don't you?

A. I live at Basin.

R-Q. 228. You know pretty nearly what dumps are there, don't you?

A. Yes, I ought to know.

R-Q. 229. If there were any other dumps there you would probably know it, wouldn't you?

A. Yes, indeed.

MR. WILLIAMS: That is all.

WILLIAM MASON GROSVENOR, called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 1. State your name and residence?

A. William Mason Grosvenor; 125 West 58th street, New York City.

Q. 2. What are your qualifications as to scientific matters involved in the process of froth flotation concentration of ores?

A. My under-graduate training was obtained at the Polytechnic Institute at Brooklyn, where I pursued both the chemical and engineering courses for five years, and received the degree of Bachelor of Science. As a matter of fact I was interested in physics and chemistry a great many years before I went to college and was experimenting with them.

After graduating I returned there as Dr. Peter Austin's assistant and did teaching work for a year. Dr. Austin advised me not to continue teaching work but to pursue my course and I went to John Hopkins

William Mason Grosvenor.

University, where I took the major courses in chemistry with physics and mathematics as minors, the chemical work being under Dr. Remsen, the physics and mathematics both under Roland and Ames. The physics and mathematical work was completed the first year and it then became necessary for me to do some practical work, interrupt my education. I went west for some New York people—came west to investigate the iron ore and gold and silver ore mining and treatment, the iron in Michigan and Minnesota and the gold and silver in Cripple Creek and some other points in Colorado. After that I became chief chemist of the Costner Electrolitic Alkali Plant in Saltville, Virginia, where I became especially interested in electro-chemical work and was then able to pursue my educational work, so that I went to the University of Pennsylvania to get the electro-chemical work under Professor Smith. There I also had physical chemistry under Professor Harden and physics under Dr. Barker.

Since leaving the University practically all of my time has been devoted to technical work.

Q. 3. Did you refer to the fact of any degree received at the University of Pennsylvania?

A. I failed to mention that I received the degree of Doctor of Philosophy in 1898.

Since leaving the university my work has been almost exclusively the study and investigation of industrial processes and the principles on which they depend, generally with a view to improving their commercial operations, and occasionally with a view to

patent distinction or characterization. The first work that I did was the investigation of the electrolytic gold extraction process, which never became practical. The theory was all right, there was plenty of theory, but it was one of those cases of an invention that fails because of some perhaps perfectly obvious practical point that had been overlooked because no one happened to think of it. Then I undertook work for the Ampere Electro-Chemical Company, a corporation organized to do inventing and developing work in scientific lines. With that were associated C. S. Bradley, men like Prof. Pupin, of Columbia University; Messrs. Crocker & Wheeler, of Crocker, Wheeler & Co., and Cooper Hewitt. In 1900 I went to the General Chemical Company as ~~general~~ assistant superintendent of ~~the~~ plants manufacturing chemicals, and two years later to the investigation department of that company, where the work was the examination and investigation of means of improving our own processes, and also of new processes brought in for the consideration of the company. I then became superintendent of the Contact Process Company of Buffalo, which had purchased and was in the process of installing a number of new processes from Germany, and was compelled to do a good deal of studying of new methods. there After that some work was done in the design and construction of conveying and handling machinery as a contractor, and in that work I came in contact with a number of technical and mechanical problems in the new industries that were being installed at Niagara Falls. From 1907 to date

William Mason Grosvenor.

I have been engaged in consulting practice in New York City, and my work has brought me in fairly intimate contact with a number of colloids, such as glue, leather, paper and celluloid.

Q. 4. When did you commence to give any study to the subject of the flotation concentration of ores?

A. About the beginning of 1914, when I undertook for Minerals Separàtion, Limited, a study of the process, the literature, and the principles—particularly the principles upon which the process relied, as far as could be ascertained.

Q. 5. And in the suit of Minerals Separation Limited, against Miami Copper Company, which was tried at Wilmington, Delaware, did you give any testimony and do any work in connection with that suit?

A. I did a great deal of work in the preparation for the suit, and made a great many hundred tests, and photographed a number of them, using the moving picture method of photography, and testified during the trial, and presented the pictures of what happened under given conditions with given materials.

Q. 6. Were those pictures exhibited to Judge Bradford?

A. They were.

Q. 7. And put in evidence in that case?

A. They were.

Q. 8. And were they exhibited to the Circuit Court of Appeals of the Third District at Philadelphia during the argument of the appeal?

A. They were.

William Mason Grosvenor.

Q. 9. In the course of your study of flotation have you examined the operations of the mills that were operating the process?

A. At the Miami mill, at Inspiration—where I had of course more opportunity to discuss the processes with men who were working it—and at Anaconda; also at the Butte & Superior.

Q. 10. Now, the—before going into a consideration of the phenomena, will you define the terms of the art, insofar as you propose to use them?

A. In order to avoid confusion, I will try to use mineral and gangue in the sense that by mineral I mean sulphide or similar non-wetting portion of the ore, including sometimes metal; and by gangue, the silicious or other portions of the ore not mineral.

By oil I mean the undissolved portions of the liquid, or easily liquified organic bodies, having a preference for wetting minerals as compared to gangue. I do not mean vinegar or acetic acid of any strength, or alcohol, or dissolved phenol; that is, I do not mean to refer to them as oils.

By frothing agent, or mineral frothing agent, I mean a body capable of producing a highly mineralized froth by the addition of it alone to a properly aerated and agitated pulp. An oil may be a mineral frothing agent. A soluble frothing agent is one which is dissolved in the water of the ore pulp.

When I speak of selection and selectivity, I mean the act or power respectively of attaching to one body rather than to another.

William Mason Grosvenor.

By affinity and attraction I mean the tendency of one thing to attach itself to another (without going into the question of whether the reasons are physical or chemical) and to remain thus attached, or by preference in close proximity.

When I speak of a film or layer, I mean to try to make some distinction between the two, because a film is a thin layer, and while it is true *that no major limit can perhaps be set to the thickness of a film,* I should regard it as absurd to speak of an oil film or *adsorption layer* anything like 1/100 of an inch thick.

Now, in regard to adsorption, I think the use of that word should be limited to the increased concentration of a dispersoid within the adsorption medium at the boundary of the medium, a strictly surface effect. Now, a dispersoid is anything that is dispersed, like salt dissolved in water, or colloidal slimes, so-called, suspended in water, and the water in that case is called the dispersion medium, the thing in which the dispersoid is dispersed. That was the definition I prefer of adsorption, the drawing together or concentration of this dispersed material at the face (the limiting face) of this dispersion medium—the meaning which Van Bemmelen ~~[illegible]~~, the originator of the term, preferred to give it. However, the defendant's scientific experts have used the word adsorption in its far more general sense, meaning the unequal distribution of the substance at the boundary between two phases, and I think it would be wiser to have that meaning for the discussion. For instance, we speak of two phases.

water and air where they meet. We speak of those as a liquid phase and a gaseous phase, and it is in that, at the interface, that the water is forming a layer increasingly dense as it approaches that face, and increasingly heavy (that is, in the sense of specific gravity) and the air, as it approaches that interface is increasingly condensed and will form a very, very thin layer thereat.

I want to avoid the sort of confusion which seems to me ~~to~~ may arise if we do not stay with one definition or the other. Professor Taggart, when asked if there was not an adsorption layer at the oil-water face (Diagram 7, exhibit 130, Q. 142 and 143), answered: "Adsorption of What?" and went on to say, "I don't know of any particular adsorption there that is of any importance in the discussion. It is possible, it is true, that if there is present in either the oil or the water, any contaminant, there will be adsorption of that contaminant at that interface, but I do not know of any such contaminant in the flotation process." For instance, there he seemed to use the a Van ~~Beumuelen~~ Bemmelen definition. In answer to question No. 146 he has changed his thought, or the idea is changed, and he said: "There is a layer of regularly varying concentration, from all oil, less and less and less oil, to all water." In question No. 147: "Unquestionably that would be an adsorption layer." Page 904.

Prof. Bancroft has refused to regard the surface film of water varying in density where it met any limitation—where it met air—as an adsorption layer; in fact he quite scouted the idea, although he defines ad-

William Mason Grosvenor.

sorption himself, as: "Adsorption is surface condensation, or concentration," and there would be condensation—concentration in the condensation at that layer.

Also it has been said in testimony that particles of mineral .005 ~~millimeters~~ inches in diameter are adsorbed into an interfacial film. The precise dimensions are not given, but they were spoken of as the mineral used in flotation, and that is one of the intermediate sizes of particles. That was also stated in connection with the testimony in regard to Diagram No. 7 by Prof. Taggart, question 141, and was adopted by Prof. Beach, question 157, page 1014, concerning which we are told that the film may be 100 molecules thick. Prof. Beach, question 152, page 1012, "that would be somewhere in the neighborhood of four millionths of an inch." That illustrates one view of the adsorption layer, while Professor Bancroft would have us regard as an adsorption layer any thickness of oil whatever, or of any adhesive material, that will hang onto mineral or to metal; questions 160 and 161, page 1131. He might regard the butter, no matter how thick the layer was, on the small boy's bread, as being adsorbed. By adsorption, therefore, I shall try to confine myself to the film which is held to the mineral by the range of forces ~~which—by the range of forces~~ at the interface exclusively, and I shall regard as coherent the additional oil or material which sticks to that film. I think there is a difference and an important difference between those two.

By bubble I do not mean merely the air in the bubble or the outside skin or surface, which may be some hun-

dred thousandths of an inch thick, or the adsorbed film of acetic acid on the outside of that interface, which may be a few hundred thousandths of an inch thick, or the layer of oil which I should call film of oil, on the inside, which may be a few hundred thousandths thick, or the adsorption film between that oil and the air, but I mean the whole bubble, as it moves through the pulp, including everything that functions as a bubble proper. That is a natural definition and its importance becomes considerable as we go into the matter.

By attachment, either indirect or direct, and possibly very intimate between the air and the mineral, I do not limit the kind of attachment to surface tension or electrostatics, or any other cause or method of attachment, but when I speak of direct attachment I mean the direct attachment of that mineral particle to the air bubble, which is intimate and physically immediate, holding the two together as a whole, with whatever adsorption layers there may be on the surface, either of mineral particle or of the bubble as a whole. Where something comes between the mineral and the air, with a practical, substantial, effective action to separate them in space, and materially affects their inter-action, for the purposes in mind I would call the attachment then an indirect attachment.

Professor Taggart himself, quite naturally and unconsciously makes the same distinction and the same definition, when he overlooks the theoretical side on page 912, question 177: "Q. And where is the min-

William Mason Grosvenor.

eral, the metalliferous mineral product? A. 'The mineral is wholly within the bubble, the film." Then he goes on to emphasize that, not as a theory but as an observation of fact: This is direct attachment to the bubble—

Also Prof. Beach, in the answer to question 36, where he refers to "this adsorption layer, from which bubbles may be constructed, and by its adhesion to the particles they are separated from the gangue."

To illustrate this point, I want to submit a set of diagrams, of which No. 1—(I have not numbered these, Mr. Williams, and I am sorry to say we have no reproductions of them)—shows much enlarged what I have many times seen to be the position of the unoiled mineral when attached to the unoiled air bubble in distilled water.

No. 2 similarly represents the mineral particles when minutely oiled and attached to a minutely oiled bubble.

No. 3 similarly represents a mineral particle carrying perhaps a third of its own volume of oil, 8 per cent by weight in the case of galena, and attached to the oiled air bubble.

No. 4 similarly represents a mineral particle either having slightly more oil or attached to an oiled bubble that is moving or straining at the oil connection. This last condition I have called indirect attachment or linking of the mineral to the bubble by an oil neck, and the first and second conditions I call direct attachment of the bubbles, What the third condition may be is ~~in~~dependent upon circumstances, the character of oil, the kind

of agitation, the amount of oil, the shape and fineness of the mineral particles; but it is obvious mechanically that for every set of working conditions there lies between No. 2 and No. 4 a condition whereat the attachment ceases to be substantially direct to the bubble itself, as a whole, and is accomplished only by a weak neck of oil. Prof. Bancroft correctly described this in his answer to questions 118 and 119 on pages 1109 and 1110, and correctly made his statement regarding what would happen when too much oil or too heavy a particle was used, that is, too much pull on the indirect attachment link. He says:

"The oil would neck off and the particle would not be lifted."

Now, this neck of oil or an amount of oil which under working conditions permits the formation of such a neck, I regard as a means of indirect attachment between the mineral and the pulp. Such oil is not a proper part of the bubble because it does not contribute in any way to the proper functioning of the bubble, nor is it a proper part of the oiled mineral because it interferes with the natural behavior of the mineral particle. Instead of promoting the function of either bubble or mineral particle for the purposes in hand, it is simply a mass of oil within which the particle of mineral has been entrapped at one point and within which the bubble of air has been entrapped at another point. Each of them is beyond the influence of the forces of the other. That, I think, should make perfectly clear what I mean and have meant by the strong direct attachment

William Mason Grosvenor.

of mineral to an air bubble or, more briefly, to air in the presence of a frothing agent. I may sometimes speak of the attachment or the affinity of air for mineral when minutely oiled in another sense. In my opinion it is quite possible that there should be such attachment directly through an oil layer, if the oil layer is sufficiently thin, though it is obviously not necessary or essential to the success of the air froth process, so far as we can see today. I mentioned it here because it will serve to clear up a good many uncertainties with regard to the relative thicknesses of these films of one kind or another.

Quincke assigns a range of molecular action as about two millionths of an inch; Plateau reached a value of five millionths by the limiting thickness of glycerine films; Parks by the wetting of powders reached a value of six millionths, this being their determination of the so-called range of molecular action, which means the reaching out of the forces which we understand causes concentration at surfaces. Now, Lewis, in 1910, concluded as the result of many experiments on adsorption at the oil-water interface, that the adsorption films, in the case of one of the least actively adsorbed material, was about six millionths of an inch.

Devaux, in 1912, proved that the maximum thickness of certain oil films on water or mercury (which I regard as comparable with our minerals or metals) before globules began to form, exhibiting the action of oil in bulk, was six one hundred millionths of an inch and that these films became stable against the thicken-

William Mason Grosvenor.

ing action of lenses or of an excess of oil when the films reached a thickness of about twelve one hundred millionths, even though there is more oil than required to make up that particular layer and enough to build up and form either globules or lenses on the surface of this layer. The layer remained stable against these. It was shown that the rest of this film would not increase beyond about ten millionths of an inch. Now, we have therefore the minimum oil layer, according to Professor Bancroft, about one ~~one hundred~~ millionth of an inch, somewhere in that general range. The maximum about six, on top of which or around in which there may be respectively globules or lenses, and if these lenses are present then the layer becomes slightly thicker and we have one, the layer which is stable against lenses.

It is simpl~~y~~e to use one hundred millionths of an inch, which we will regard as the unit, and simply taking the number of one hundred millionths concerned only. In passing it might be well to emphasize the fact that the one hundred millionth is a pretty small unit for flotation or for mineral particles that are used in flotation.

Now, the range of molecular action or the reaching out of one kind of matter to affect another, the reaching out of one unit of matter to affect the mass of matter itself, has been stated by Quincke as two hundred, Plateau as five hundred, Parks as six hundred, Lewis (in the sense of the adsorption layer at the oil-water interface) as six hundred, and by Professor

William Mason Grosvenor.

Taggart, if I recollect, about two hundred. We have for comparison then those ranges—from one to ten, and from two hundred to six hundred, the one to ten being the thickness of an obstructing oil layer; the two hundred to six hundred being the range of molecular action of the mineral to reach through oil and affect other air on the other side.

I believe, therefore, that I am justified in thinking that two hundred ~~hundred~~ millionths range of molecular action or six hundred ~~hundred~~ millionths range of molecular action can easily reach through an oiled film which is only one twentieth or one sixtieth of that thickness. This will be particularly true if it is admitted that one side of the oil film is partially mixed with air and the other side of the oil film is partially mixed with mineral.

MR. WILLIAMS: I now offer in evidence the diagram referred to by the witness, diagram number 1 as plaintiff's exhibit 237.

Diagram admitted in evidence and marked ~~DEFENDANT'S~~ Plaintiff's EXHIBIT 237.

MR. WILLIAMS: I now offer diagram number 2 as plaintiff's exhibit 238.

Diagram number 2 admitted in evidence and marked PLAINTIFF'S EXHIBIT 238.

MR. WILLIAMS: Diagram number 3 as plaintiff's exhibit 239.

Diagram number 3 admitted in evidence and marked PLAINTIFF'S EXHIBIT 239.

MR. WILLIAMS: Diagram number 4 as plaintiff's exhibit 240.

Diagram number 4 admitted in evidence and marked PLAINTIFF'S EXHIBIT 240.

THE WITNESS: Now, illustrating the importance of the thickness of the stable layer which we have stated as having been determined by Devaux a~~s~~t about ten one hundred millionths of an inch, and the importance of the fact that ~~that~~ it is stable against the presence of lenses or nodules of oil. Suppose we have a part of the film of the bubble which we will draw of a minute thickness, as compared with the diameter of the bubble. We will call the lower portion of the diagram "W" beneath the film, the water; "O" the oil and "A" the air above that film. Now, certainly in level films we find that when that ~~layer~~ film is thickened beyond ten one hundred millionths, nodules gather. I have observed the phenomena, but can claim no credit for having determined it or having discovered it. If the film is contracted the little nodules bristle upon it. In some cases it occurs rather as a thickening of the layer, one side or both sides. One such nodule we will mark "N," and the lens "L." The presence of such nodules or lenses does not interfere with the importance of the general statement of dimensions that we have made because the film of ten one hundred millionths is in many cases at any rate stabilized against the presen~~t~~ce of these nodules or lenses.

MR. WILLIAMS: The diagram made by the wit-

ness is marked diagram number 5, and I will offer it in evidence as exhibit 241.

Diagram number 5 admitted in evidence and marked PLAINTIFF'S EXHIBIT 241.

A. (Continuing.) Before proceeding with a detailed discussion of the phenomena which may be regarded as essential or vital to flotation, it will be well to familiarize ourselves a little with the materials being used for testing and examining these phenomena, and to remember that we are not attempting to pursue any industrial result, but to examine into certain principles, general basic principles, as explained by the character of materials that enter into flotation. It will be equally profitless to theorize about that on the one hand or to try to analytically consider a given flotation operation going on with the whirl of material on the other. If we desire to measure the effects and eliminate guesswork we must make a quantitative analytical comparison of the forces involved. And in order to do that, we must use mineral particles which are large enough to test to the limit the forces that we wish to examine so that we may quantitatively measure the ability of these forces to overcome strains like the jerks and twists which the particles must undergo during agitation. For this purpose we may use galena particles carefully selected—carefully selected because we want them cubical as nearly as possible or carefully measured so as to ascertain the periphery or length of the line around the top where attachment is likely to take place, or the medial line where attachment seems

William Mason Grosvenor.

to take place and frequently the particles stick clear up into the bubble. And we may go further, where we want readily comparable quantitative results, satisfying ~~to~~ ourselves that the galena particles attach to air bubbles in the same way that aluminum particles do; that aluminum particles exhibit the same degree substantially of attachment when they are clean. By "clean" I mean carefully cleaned in the sense which Professor Beach so well described—because the slightest trace of oil acts as a changing or modifying material. ~~and~~ If we take particles of a fixed diameter and vary their thickness, we secure a sort of scale of weights which we can use in examining the phenomena. In making these comparisons, and in particularly in making the photographs it is important to use perfectly plain plate glass vessels or faces through which to photograph, so that there may be no distortion. And it is also important in some instances to use a bottom for special purposes, (You might call it a false bottom), which will not wet with oil and which will therefore enable us to use oiled particles without fear of their attachment to the bottom of the vessel. The galena particles are selected and weighed. Their size is illustrated by ~~the~~ these three particles, six, sixteen and twenty milligrams, which have been used for some of the work, that being a six milligram particle, this second one sixteen and the third a twenty milligram. I give these weights roundly at the nearest unit because a variation in the particles and a variation in the accuracy of the face of the particle is greater than makes it

William Mason Grosvenor.

necessary to give weight to decimal place. For purposes of comparison, for accurate calculation I used a set of aluminum punchings varying in thickness but not in diameter. 5/32″ was chosen as a convenient diameter and the thickness used gave nine milligrams weight for the thinnest, 17, 28, 35, 42, 54, 64, 75, 89, 98 and 104 milligrams are the consecutive weights of the particles used. To illustrate some processes, particularly to make grossly visible the oil neck and the action of oil and water when mineral is passing through the interface between the two, I have used a large aluminum particle about an inch in diameter which can be floated, when clean, but which for this purpose (passing through the interface) must be suspended by threads that are exceedingly thin.

We shall illustrate some of these simple manipulations, by lifting the metallic and mineral particles. 104 milligrams of the standard set is the largest that I have yet been able to lift—but, owing to the present conditions and the difficulty of getting them perfectly clean, it will be illustrated with a lighter particle. We will then apply small or large quantities of oil to the particles and try to lift them, and then illustrate the effect of moving the bubbles so that we may roughly compare their lifting or attaching power with that of what has been called the captive bubble. Professor Bancroft, I think, used the term "free bubble" in another sense, to represent the bubble after it has passed out of the surface of the liquid or when it was lying in the surface of the liquid. I use "free bubble" in the

William Mason Grosvenor.

sense of a bubble not held, and I speak of this only that we may avoid confusion in reading the testimony. Prof. Bancroft was perfectly right in the use of "free bubble" as he uses it, but to make the distinction from the captive bubble which is held in a bubble holder, I will describe this as "free bubble." The bubble holders are of various forms. For handling a large particle it is more convenient to use a bubble holder of that form (showing bubble holder). For handling smaller particles a bubble holder of this form is used, and the bubbles are made by injecting air from a dropper into a liquid under the bubble holder, as illustrated by Prof. Taggart in his experiment. In this way we may determine quantitatively, although often roughly, but still quantitatively, the actions, forces and relations between the materials we have to consider. In the pulp we have air bubbles, water, mineral, gangue and oil, or a soluble frothing agent, and an electrolite acid or salt, and these are all present with agitation. We will see in some cases how they react. In order to save time in the handling of materials and cleaning up of vessels and so on, I want to present many of the things later as pictures, also partly because they are in more permanent form, and clearer than any description that I can give. The first question that we may ask ourselves is, does air alone lift mineral? We shall show, both by direct observation and in the pictures that it does. And how much 45 milligrams of a nearly cubical galena piece, which is far more of course than is necessary in practice; but it is a measure of the

degree of attachment on which we can rely under certain conditions of cleanliness and length of attachment line. It is the measure of force on which we can rely to hold a bubble and a mineral particle together. One might infer that perfectly good flotation could be made in pure water. In practice, however, the mineral does not hold on to its bubbles. The question then arises, does the oil lift the mineral? We shall see that it lifts only very small pieces of mineral, less than a five milligram galena cube, with oleic acid and spindle oil, for instance, and that this attachment is weak and wobbly; that oil, if present in considerable quantity, tends to break up into globules, while, if the quantity is small, it tends to break up by pulling apart between the mineral and the air.

Whereupon an adjournment was had until 2:00 p. m. May 8, 1917.

2 p. m. May 8, 1917.

THE WITNESS: We were discussing the phenomena which occurred when oil, water, and mineral particles, etc., were brought in contact in various ways, and were planning to illustrate, first the direct attachment of air and mineral. In the first instance, we will use aluminum particles, because it is a little bit easier to observe what occurs with them, and because I have satisfied myself that they behave in a general way and to a large extent quantitatively just as do the particles of galena or other mineral.

In the first place we have there the small particles

floating on the surface. If it is knocked down, it settles to the bottom, and if an air bubble is made in the bubble holder by the use of a dropper, similar to the one illustrated by Prof. Taggart, and the bubble is brought down in contact with the particle, the particle will be attached to the bubble and raised. (Illustrating) Now, on a large bubble we would have a nearly flat surface. It is possible, in the case of air, to raise the particle right through the surface and lift it out, still attached to the surface of the bubble. The particle in that case is in direct contact with the bubble, drawing the film of air down. That particle, probably, has in the extreme sense some impurity—grease, on the surface of it. Taking the successively heavier particles one after the other, if we cared to give the time to it and could give the time to it here, careful purifying of those, we would find that in each case the lifting was easier, the attachment was better in the case of the thoroughly purified particle; and as we reached the upper limit of what we could lift under normal conditions, which would be about the 54 milligram particle of this set, which I exhibited previously, we might be able to lift 69, but when we got higher than that we would find that it was very desirable, if not absolutely necessary, to take those particles out and give them a most thorough cleaning, and use pure matter, and to avoid any grease in the vessel. The 104 milligram particle I have lifted repeatedly, when I was working under conditions where I could have everything perfectly clean, carefully washed, and use distilled wa-

William Mason Grosvenor.

ter—re-distilled water in fact, distilled the second time —and drawn from the lower portion of the vessel, so as to avoid any possible oil film that might have gathered on the upper surface of the liquid.

I want now to illustrate something corresponding perhaps to the overloading of the surface with sufficient of these particles have been placed side by side. They will ultimately draw together and break the surface down, but then as they stand now together in there, floating in contact with one another on the surface of the water, that illutsrates what has been called the viscosity of the surface; and it seems to me that is somewhat stretching the use of the word "viscosity" because viscosity I think properly used does not imply any maximum of resistance to extremely slow movement or extremely weak forcing. These things are absolutely rigid, the one against the other, up to a certain small force, that they begin to acquire. In other words, a film of that kind behaves much more like a rigid body, up to very small limits, than does a truly viscous film. But I think anyone who has seen that phenomenon or who has examined the surface of the bubble coated with mineral particles will feel quite reconciled to an "armour coated bubble" or an "armour clad bubble". The lifting of these can be observed. At this time I may say that if any one cares 6 to see the condition of the particles lifted that way and suspended in that way it can be done here. It makes no difference whether the particles are lying on the bottom and picked up by the air or whether we go

down and pick them up. The net result is just the same. In some cases the particles may overlap a little; in some cases they may stand edge to edge. In this instance one of the particles which had not been knocked down to the bottom was picked up by the bubble, a large bubble about three quarters of an inch in diameter, which was already laden with six of the particles which had been hanging on the surface.

Q. 11. Describe what you have done?

A. I have taken a large sized bubble holder and brought it down upon the surface of the liquid at which were already floating six aluminum particles .012 inches in thickness, and weighing about 9 milligrams each, while there was also a similar particle lying at the bottom of the vessel. This descending bubble holder, however, caught the surface of the water and formed a bubble with it which carried down the six particles. The bubble was then carried down to the bottom and picked up the seven all attached to the bubble. Now, these particles, so far, have illustrated direct attachment to the air, as I call it, because the air is in direct contact with the particle, and it seems to me to prevent the extension or contact of the water with the particle. Large particles can be lifted in the same way and it is for the purpose of quantitatively examining the relative strength of attachment under different conditions that large particles are used. A 69 milligram particle is now placed upon the surface and floated with the others. It is knocked down to the bottom, and in order to get the comparable condition

William Mason Grosvenor.

I want to have the smooth surface of the punching, so that I turn it over and place it on the bottom of the cell.

Q. 12. What surface now is uppermost?

A. The surface now is uppermost which was next to the bearing plate of the punch when the punching was made and which therefore is smooth and has its edges very slightly rounded, in contradistinction to the other surface which was roughened by the contact with the punching tool and has the edges slightly drawn into the minute interstices between the punch and the die.

Q. That is, so that there is a burr around the edge?

A. There is a slight burr all around the edge which would interfere with a comparison of the results and as we are working in the neighborhood of the upper range of lifting under these conditions, it might prevent the lifting of the particle. If the particle is clean it will lift; if not we will have to step down the line and take a smaller one. The particle is not clean, does not lift, and a peeling of the bubble away from the surface is of such a character as experience has taught me to recognize as the presence of a little grease. Experience has also shown me, however, that the presence of that grease in time can be offset, as I believe, by the distribution of the grease over the bubble so that when we are working at the limit by rubbing of the bubble even on the supposedly solid grease that is attached to the particle, we are able by this means to distribute the grease over the bubble

and make a thinner layer on the particle so that now we can lift it, although somewhat precariously owing to the trembling of the hand. As we work with it the attachment would become strong and ultimately I think we can lift it quite reliably. At present it has been held up for five or six seconds in spite of the trembling of the hand which tends to shake the particle loose. Now, working as I say under extremely careful conditions to insure the purity of both the particle and the bubble, I have been able to carry the 104 milligram particle. If we take an amount of oil or grease of any kind which is what might be called tangible and apply to these particles we will find that the power of lifting, the strength of attachment is very much less indeed. And perhaps a striking illustration of that may be obtained with a very large particle if you choose to call it a particle. I have here an aluminum disc which is approximately an inch in diameter and weighs something over a gram. If a considerable degree of purity has been obtained I will be able to lift that particle. It has been washed once very carefully, and I think we may be able to raise it. When that particle has been raised, if we succeed in doing it (it is close to the limit) you will find that passing that lightly over any part of the body, (the hands, but particularly the nose), sufficiently greases the particle to carry it well below the lifting limit, and it will be impossible to raise it. In a similar way, particles which have had a small amount of oil applied to them, minute in any commercial sense, fail to lift when brought in contact with the air bubble.

William Mason Grosvenor.

The reason for attempting to carry out this sort of lifting with varying sizes of particles and varying degrees of purity and varying amounts of oil is in order to examine quantitatively the effect produced by the different factors in different proportions as they enter into the fundamental operations of flotation. (Witness fails to lift the particle). The large particle is just on the limit of lifting, and I am afraid that needs another bath. This as shown emphasizes the extreme degree of purity it is necessary to use when we are working at the limits. That, by the way, is the particular piece used in raising the large aluminum disc in the picture that I plan to show later, and that was raised and lowered through the interface between oil and water, not merely to show the carrying power of the oil-water surface, which is far less than the air-water surface—but also to show the character of the necking out and pulling away of the oil, which we shall see clearly illustrated later. (Witness sends aluminum disc to be again washed).

I want also to show the action of the bubbles on the galena particles, and then the action of oil in considerable quantities as affecting the attachment of that galena particle to the air bubble. I have here a particle of galena, weighing 14 milligrams, and a glass cell having a false bottom of cloth, so as to prevent the sticking of the oil to the bottom of the cell. An oily particle coming in contact with the glass bottom of the cell is in danger, unless precautions are taken, of oiling the bottom of the cell and producing

a cohesive action between the oil on the bottom of the cell and the oil on the particle, the result of which would be to retard, and possibly prevent entirely the lifting of the particle.

Placing the small sized bubble holder in the water, which occupies about half the height of the cell, and making a bubble in the holder, we first bring the bubble in contact with the clean particle of galena, weighing about 14 milligrams, and raise it from the bottom of the cell. It will be seen by rocking the cell and jarring the bubble holder that there is a considerable degree of attachment; that the particle is rather strongly held to the bubble holder and waves from side to side without being detached; if that particle is now oiled, we will observe a very different condition; we will pick it up again, and in order to avoid any jarring or vibration of my fingers I will allow it to be held by the clip so that it may be more carefully observed; the bubble holder is held by the clip, so that it can be really examined.

Now, removing the particle from the bubble and dropping it on the bottom of the cell—

Q. 14. MR. SCOTT: Will you remove the particle from the water and see whether it is wet or not?

A. Surely. Every opportunity that is given to the particle to pick up air on its surface and attach itself to the air will be welcomed by the face of the mineral. How would you like this removed, Mr. Scott? Of course if I take it up with a glass surface

William Mason Grosvenor.

we have an entirely different set of conditions from taking it up with a metal surface.

Q. 15. Can you lift that particle up on the bubble?

A. I think not; I think it is rather too large to do that, but I will try to do so. I will try it, but my impression is that it is above the limit which, for these conditions, will permit the lifting through the surface. If, however, I had a surface surmounted or covered by other bubbles, so that the supply of liquid was ample, this particle could come up on one bubble and float up through a series of bubbles. That is an occurrence which it is a little difficult or practically impossible to perform under these conditions. In order to avoid the breaking down of the bubble surface in the pure water, to which Professors Beach, Taggart and Bancroft have testified, and it is perfectly correct—I must change the condition and will have to supply a layer of liquid in which it may lift, so I will have to make my bubble somewhat smaller—~~also~~ there is Ah! your particle carried through the surface on the bubble and hanging to the face of the bubble in a film—(witness to Prof Beach) The gentleman is now yours; he has fallen off on your hand.

Q. 16. MR. SCOTT: Did you observe whether the particle was wet?

A. It is still wet in parts, and it is also dry in other spots where the water has retreated from the surface.

Q. 17. Is it wet underneath?

A. Oh, yes, it is wet underneath, because, hang-

ing under the bubble, there was a layer of water in which the particle was suspended by direct attachment with the bubble.

Q. 18. THE COURT: When it lay in the bottom of the vessel wasn't it wet?

A. It was then thoroughly wet. I never have been able to detect with any certainty a layer of air on the particle. Very frequently a particle falling in that way through the liquid, will carry down a bubble with it, attached to a portion of the surface, but I think careful observation of that will indicate that there is no layer of air.

Q. 19. THE COURT: If you scientific gentlemen can not see it—

A. Either through our eyes or our imagination? (Laughter.)

I think it will be found that there is no visible air on the surface of that particle. It is true that when that particle is allowed to stand in the water for some time, and observed with a microscope, there are very frequently collections of air on points; but, taken as a whole, I have never found the particles otherwise than wet when under water.

Now, if we leave that particle on the bottom and apply to it a small amount of oleic acid or pine oil or kerosene or any other oil with which I have experimented, we find that under the conditions here of substantial wetness over the whole surface of the particle, the oil does not spread beyond a certain point. Dr. Taggart's diagram of his experiments when oil was

dropped through the surface of the water to the upper surface of the mineral, very accurately represents the condition, and the oil gathered as a dome on the portion of the particle to which it is applied. Of course with agitation that can be spread all over the surface. I will try to apply a small quantity of oil to the surface of the particle, making the amount as small as possible. In doing so, of course we contaminate the surface of the water, flashing an oil film over that surface the minute we touch the oily dropper to the surface.

Q. 20. MR. SCOTT: What kind of oil is that, Doctor?

A. I am using oleic acid. I have done the same thing with kerosene and pine oil and some 8 or 10 different oils that I can not remember just now. After the particle has been under the water for a little time it is somewhat difficult to get the oil to attach to the particle, without actually rubbing it on. Furthermore, the surface of the dropper being oily, the oil prefers to travel up the dropper, rather than seek a new path to the mineral, but with a little persistence it is almost always possible to apply the oil directly to the surface of the particle and leave a dome of oil attached to the mineral, as the mineral lies on the bottom of the cell. A small bubble of air is observed in this cell, to have come out of the dropper with the oil, and to be entrapped in the oil, but not to be in contact with the galena. If, now, we undertake to take that particle up with a bubble, we will

observe the necking out or necking off of the oil, which has been described by Prof. Bancroft. I should ~~could~~ estimate the amount of oil on the particle to be, perhaps one-fifth to one-tenth—somewhere around that, of the total volume of the particle.

The surface of the water I note has several oil globules on it. These demonstrate the condition described in the diagram this morning of a minute film of oil covering the surface of the water and stable at a minute thickness against the presence of oil lenses which are floating at the surface. In going down for a particle I will blow upon the side of the water endeavoring to force away that minute film so as to get below the surface with the least amount of oil which I can. Generally, by blowing on the surface that way, the film can be forced aside so completely that the bubble holder which has been entered below the liquid does not carry with it any film of oil. In the same way, for the same reason I will bubble the air out of the dropper before I make the bubble, so as to remove so far as possible any oil from the equation except the oil present on the particle itself. Of course that really doesn't matter very much because there is so much oil on the particle, but what I want to illustrate is the action of a substantially clean bubble in the bubble holder, taking such precautions to avoid the presence of oil on the surface of the bubble, and we will lower the bubble as gradually as possible until it apparently makes contact with the oil without bringing it any closer than that. At a certain point it

P. 4190, L. 27, insert "and an evenly oiled particle; We have now made the bubble" before "in"

William Mason Grosvenor.

seemed to me that there was a slight deformation of the bubble before contact was actually made. In the picture that I hope to show you later there will be seen quite clearly the bumping side of the oil globule by the air bubble, due in all probability to the minute film which is formed on the surface of the oil in the water and the minute film which is formed on the surface of the bubble in the water. Your honor will observe that once the contact has actually been made between the particle and the air bubble, the oil stretches out as a neck. I might observe likewise, a certain change in the appearance of the bubble, a little larger just at the instant of contact, which was due to the sudden spreading of this minute film of oil over the surface of the entire bubble; and, if we could overflow this liquid so as to carry all oil away from it, and enlarge the bubble, and withdraw the glass we would find that the surface of the glass where the bubble joined it was slightly contamihated with oil, showing the presence of that film over the surface. Now, going down, as we have, coming in contact with the particle and slightly moving the dropper and the bubble to one side, we observe the under surface of the bubble (in addition to this layer which we cannot see because it has now finished its flash and is so minute that we can only observe it by a change of reflection on the bubble), in addition to that layer which we know is there, which we can prove in many ways is there, we have a minute globule of oil which is dangling on the bottom of the bubble. Another illus-

tration of contact with a film. Going down on the surface of the oil and this time going down substantially so as to make a good contact, and not make the oil reach out, and now slightly raising the bubble, we see again clearly the drawing together of the oil upon the surface of the particle and the surface of the bubble into a neck which, as we gradually raise the bubble, draws out and breaks. Now, if we select a portion of this surface and clean it of all visible oil globules and tip the bubble holder up so that the bubble rises to the surface and breaks, and examine the surface, we find a minute particle of oil lifted there by the bubble. Can your honor see it right at that point, see the little particle of oil floating on the surface?

THE COURT: About five of them there.

A. They are very apt to break up and separate and very possibly some of these may have been lifted from the other bubbles. But, repeatedly, I have insured the absence of such residual oil by sweeping the surface over the top of the glass, flowing clean water in at the bottom, and then taken one bubble and seen the particle of oil raised by that bubble. A further indication of the removal of oil by the bubble can be had by making the bubble over again, repeating it rapidly, and notice the clear decrease in the amount of oil each time. Each time the bubble is brought in contact with the particle it similarly draws out a little bit of oil which breaks off with the weight of the particle as it is doing now, and carries away with the bubble a decreasing amount of oil. The bubble can be raised

William Mason Grosvenor.

to the surface again and again and will ultimately carry nearly all the oil away from that particle. It takes a great deal of time to carry quite all of it, but it can be done. It is easier to do it evenly with a stream of air bubbles than with a succession of individual bubbles. Therefore—

MR. WILLIAMS: Q. 21. Now, state what you are doing?

A. We have now a small tube from which air is issuing in bubbles, underneath the surface of the water, and we bring these bubbles, one after another, in contact with the surface of the oiled mineral. And as the bubbles pass, one after another, knowing as we do that each bubble takes a little oil, we are not surprised to observe that the particle begins to show activity and jumps towards the outlet of the air. Passing the bubbles slowly in that way it takes a great deal of time to remove the last traces of the oil in the case of oleic acid from the mineral. By more rapidly bubbling, the oil is removed, one portion after another, and as the particle is scoured and washed with air we gradually reach a condition where the particle is capable of attaching itself directly to the moving bubble and rising to the surface. Whether that will happen in this particular instance in the time we have to give to it I do not know. Apparently cracks in the mineral and different characters of surface of the mineral have a great effect on the length of time that it takes for the air to de-oil the mineral. The mineral particle hopped perhaps a sixteenth of an inch off the bottom, then, under the action of the bubble so that I am

William Mason Grosvenor.

led to hope that this may give us the desired result without too great an expenditure of time. The particle is becoming more and more active but does not yet seem to be cleaned up. Now the amount of oil or impurity that is required to produce that blanketing action I know to be minute. The exact amount is extremely difficult to ascertain because as I stated the character of the surface, the kind of oil, the position of the particle, the shape of the particle all effect that precise limit, if it be precise; and it is generally so small that we cannot follow the effects of these different factors. It jumps. The movement is so quick that it is very difficult to follow. I have had them to go to the surface a great many times and come down when I didn't quite know it, just see the difference in the position on the bottom. If the particles are very large however and unless the bubble happens to be a large one the movement is generally slow enough that it can be observed. It sometimes takes a very long time to remove the oleic acid completely enough to get a result.

Witness takes up aluminum disk sent to be ~~remarked~~. washed

We will temporarily leave the air bubbling over the particle and return to the large aluminum particle which was previously too much contaminated to lift. One reason for the failure to lift a large particle of this kind under these conditions is quite frequently attachment of the particle apparently to the bottom of the

P. 4195, L. 23, insert ", you notice the water on the upper surface " after " surface "

William Mason Grosvenor.

vessel as it can be observed in this case by the fact that is is hard to turn it over. We will therefore support this disc a little away from the bottom of the vessel on a couple of small aluminum pieces, when we try to repeat the operation. The manipulating difficulties of the work are considerable and it is for that reason that I preferred to save as much time in showing a varied range of experiments as possible by recording the results in the form of pictures. In spite of these difficulties, however, after a considerable range of experiments it becomes quite clear that the general phenomena are perfectly reliable and the quantitative results are entirely reliable if not always absolutely concordant. The way in which the water withdraws or fails to withdraw from the surface of the particle frequently indicates the degree of cleanliness and in this case also I find that the particle is not entirely clean. You will observe that the large aluminum disc has been lifted clear off the bottom hanging in the inner surface of the bubble. Now, referring to the question of wetness or non-wetness of that surface of the aluminum particle right inside of the bubble. That is quite a layer of water lying on the upper surface and including—do you see the little globes of water lying on the surface of the particle.

THE COURT: Yes, I see them.

A. That is an evidence of more or less irregularity and impurity of surface and it is that increased weight which makes it difficult to lift.

THE COURT: You mean a little collection of water?

William Mason Grosvenor.

A. Yes.

THE COURT: Is there a text book on bubbles?

A. I know of only one book on bubbles that is perhaps authentic and that is Rayleigh's work on foam. Bubbles in this connection I don't think have been written up by what might be called any authorities. A great many papers have been written, general articles, and a very considerable portion of the work is quite accurate if we stick to the statement of facts and do not attempt to draw conclusions as applied to this or that phase of some litigation.

THE COURT: I was just thinking, taking the testimony on both sides, you might write up a text book.

THE WITNESS: I believe we could make a very interesting and valuable text book, judging from the testimony which I have read because a very great portion of that testimony is, scientifically, thoroughly accurate and reliable.

MR. SHERIDAN: There is a small book, isn't there, professor, on soap bubbles?

A. Yes, but I was thinking more of bubbles in this relation.

MR. SHERIDAN: That is actually a very interesting book.

A. Very interesting, indeed. Now, the question will arise: what is the action of air on mineral in the presence of oil in quantity? The answer to that may perhaps be given by taking a little fine mesh galena (which by the way is merely mineral as 200 mesh

William Mason Grosvenor.

and has all the dust in it, running down to I don't know how fine), and placing some of that at the bottom of a watercell. One thing will be noted and that is that the air in that mineral has formed what might be called a bubble filled with galena, that it sticks to the metal, to the forceps and does not come off, held in by the film around its surface. Now, if we knock some of that down to the bottom of cell and get enough down there to be sure of our having minute particles on the bottom, then if we put a layer of oil above it and we have already made a bubble of air under the bubble holder in the water beneath the layer of oil, we will be in a position to examine as we raise that bubble, the effect of the air on the mineral in the presence of excess oil.

Q. 22. MR. SCOTT: Are you putting an oil layer on top on this experiment?

A. Yes.

Q. 23. On top of the water?

A. Yes. We now have a vessel half filled with water on the surface of which some galena particles are floating.

We have placed the bubble holder on a rest within the water, with the cup beneath the surface of the water. We have formed a bubble of air in the holder. If now we pour oil on the surface of the liquid we will have an uncontaminated bubble, at least if the oil is insoluble in the water, with the oil above it.

Q. 24. MR. SCOTT: Is there any oil on the bubble now, doctor?

A. At present, as far as I know, there is no oil upon the bubble. It was not made with any extreme precautions, but there is no substantial amount of oil. as far as I know.

Q. 25. No oil was put in there?

A. No oil was put in there. If there was any oil, it was the atmospheric, condensed oil film which Dr. Bancroft told us about.

On the surface of the water I now pour a layer of kerosene, and it will be seen that the aluminum particles and the galena particles float in that interface. That is one way of putting it. Another way of putting it is that we have now an atmosphere of oil on top of water, and we have an interface between the water and that atmosphere of oil, which has a certain surface tension. The size of the particles is such that they are incapable of breaking that surface tension. If the particles of galena are materially larger than 5 milligrams, they would not have stayed up there. If the particles of aluminum were materially larger than 27 milligrams they would not have stayed up there. In illustration of the last statement I will try a 27 milligram aluminum particle, and since it is on the line where the phenomena are dependent on microscopic conditions—it may go either way. I think from experience that this particular gentleman will pass through the oil layer and pass on down into the water. I have tried as far as possible not to let any unsteadiness of my hand—Oh, he has stayed there on the interfacial layer. Now, if we take a larger particle—Just how

far the limit will go with this kerosene I can not say, because the surface or ~~of~~ the interfacial tension between kerosene and water is considerably higher—with oleic acid this 28 milligram particle goes through With kerosene the value would be probably considerably higher than that. However, before seeking that limit, we will apply the bubble which we have formed in the water to some of the fine mineral at the bottom of the cell, and you will see that the bubble has picked up the finely divided mineral from the bottom, leaving in the first place a cleared disc at the bottom, and in the second place lifting the particles hanging on the bubble.

We now raise the bubble to the interface and seek to learn whether the attachment of the mineral to the air will be interfered with by the presence of the oil. I have, I think, raised the bubble to the point where the interface between the oil and water has just reached the edge of the bubble, where it joined the glass, and in raising that bubble slightly higher we draw out that interface. Now, we have raised the bubble to the point where it passes through that interface, and the interface can be seen to have swept off the mineral which was attached to the bubble, with the exception of a minute particle of water which was caught up and mixed with the oil. It will be seen that the bottom of the bubble is clear from the black mineral, and the black mineral is now hanging at the interface. This state of things particularly illustrated here, is illustrated in another way by placing the min-

eral originally in oil, and going down with an air bubble in the effort to pick up the mineral surrounded ~~in~~ with oil. (Witness puts bubble holder down again.) There are still some particles of mineral floating at the oil-water surface, and it will be noted that the air bubble is capable of carrying those particles down, attached to the film of oil which constitutes a portion of this bubble when it passes from the oil down into the water. If we raise the bubble into the oil and attempt to carry these particles from the interface up into the oil, we find that in the oil there is no attachment between the air bubble and the mineral.

Now, I have repeated that many times with mineral of the finest mesh that I could get, and the air bubble remains clean, as you now see it.

These methods are given, not as examples of flotation commercially, but as visible statements of the principles which must control in the inter-action between oil and air and mineral, as they are present in the pulp. Precisely the same kind of experiments can be carried out, in which I take modified water, that is, water in which there was dispersed—separated throughout the water—a portion of oil of soluble frothing agent. Now, the continued bubbling of the air over the particle in the water cell has removed the oil, not once, but a number of times, and the particle has jumped to the surface, picked up oil from the surface, and gone down, carrying, as I have seen it many times in the pictures, and hope to be able to show it in one of the pictures—carrying a considerable dome of oil

William Mason Grosvenor.

with it when it returned to the bottom. The dome of oil is not on it now, but that is ~~this~~ the way he goes up and gets oil and goes down again. There is no oil on there now; it has been cleaned off by the air bubble. When I say no oil, I mean substantially no oil. This particle is just at the limit of lifting with any considerable quantity of oleic acid, and there may be oleic acid disseminated throughout the liquid, so that it may account for the change from quick lifting—There, it went to the surface and dropped clear back of the bubbling tube. The smaller particles lift more readily, and it is found that, whereas a clean air bubble in unmodified water—There it is, fortunately hanging at the surface long enough to be observed before it came down again.

Referring to the experiments carried out with modified water, in the sense of water containing a soluble frothing agent which we know is dispersed throughout the water and is in position to act at the surface of the bubbles, we find that the attachment of the particle to the bubble in the sense of the weight of the galena cube that the air bubble will pick up, is very much decreased as compared with the weight of the particle which the same air bubble will pick up in perfectly pure water. We find, likewise, that using the captive bubble, in the sense of a bubble held in the bubble holder, a very much larger particle can be picked up than will be taken up by the free, moving bubble, as we would expect; the difference is something like two to one; that is, the free moving bubble

will lift only about half as large a particle as the captive bubble. The difference between the modified water and the unmodified water is not so great, being in the ratio of something like 60 to 100. In that way, using different sets of conditions and different oils and different soluble agents, different mineral particles, it is possible to establish perfectly certain relations between the strength of attachment under any given set of conditions, and the attachment under another set of conditions. While these results may not be accurate in the sense of precise to a decimal place, their range is extremely accurate and reliable, and in this way we are enabled to answer the questions which arise, or to make the physical material themselves answer for us the questions which arise in considering flotation.

Among those questions, we have spoken of the question whether air bubbles attach directly, and have seen that in the common sense use of the word direct, they certainly do, if the mineral is clean. We have likewise seen, in the common sense use of the word "direct attachment," that the mineral particle which jumped on the bubble to the surface attached to the bubble, was directly attached to that bubble. There was the surface of the bubble coming down into immediate contact with the surface of the particle. That can be very much better observed in the picture, of course, than it can be in the fleeting movement of the particle, observed by the eye.

We have asked the similar question, whether oil

William Mason Grosvenor.

lifts mineral, and find the answer that it does very little, and by taking a series of particles and carrying them out quantitatively we learn that less than 5 milligrams galena cube will be picked up by oleic acid or spindle oil, and that that varies in that general range with the different kinds of oil. We learn also that that lift is somewhat precarious when it does occur, owing to the fact that when the particle even is not heavy enough to break off the oil neck, the sweep of any current of water over that oil neck would likewise tend to destroy it. We have learned that a bubble of air surrounded with plenty of oil does not hold the mineral to it; that the mineral moves away from the bubble, in preference going to the interface on the other side of the oil—the water—oil interface. Under these conditions, with the bubble in oil and the mineral in oil, we can be reasonably sure that it does not lift even .005 of a milligram.

The question arises how little oil will cut the lifting power and produce this weak oil neck, and an examination of the phenomena has indicated that that occurs about the point when there is enough oil to come between the particle and the bubble, and about the same amount of oil which would cause that particle to adhere to a solid material through oil adhesion, if the bubble were a solid ball of metal, instead of a globe of air.

The question arises, what does the oil do, and I have found that it affects the air and the water, rather, perhaps, than the mineral; at least the effect on the

William Mason Grosvenor.

air and water is the most radical and observable effect, in the sense that it produces more persistent bubbles and more gradual joining of bubbles, which is called coalesence. In the same way, taking small amounts of the material in hand, and subjecting them to precise controlled conditions, we find that, as a general rule, the soluble frothing agents have a very great effect on this character of the bubbles under the water, the way they are formed and the way they unite or fail to unite. In this way I have reached certain conclusions regarding air froth flotation. They were reached from observation, and most of them are the mere statements of observed fact.

Air flotation depends upon these following facts, most of which have been stated in substance by one or the other or all of the scientfic experts testifying for the defense. Practically all of these facts can be seen photographically recorded and projected on the screen. They are:

First, a clean air bubble in water, whether captive or free, in the sense of free rising, in unmodified water will attach and carry mineral particles of a weight roughly corresponding to the surface tension at the air water surface, acting upon the line of the attachment of the bubble surface to the mineral. This power of attachment, measured by the gentle application of lifting, is about 40 milligram galena cube. In the ordinary sense, the attachment is direct to the bubble. One might say directly to the air.

Second, in pure water, however, air bubbles coal-

William Mason Grosvenor.

esce with a suddenness and violence which generally detaches the mineral particles. This suddenness approaches 1/12,000 of a second.

Third, an oily mineral frothing agent can be made to coat mineral particles. It can be shown, as we had opportunity to observe it there, to quickly flash a film of infinitesimal thickness, about 4/100,000,000 of an inch, over the surface of the bubbles. The figure, to be more accurate, is 4.16; and while it may seem absurd to measure a figure of that size in one or two decimal figures, the work of De Veaux indicates to me that he has determined it within an accuracy of 10%. That is his opinion, and the methods he used are so simple and direct, that I see no reason why it should not be true. That this film increases slowly to about twice this thickness over the air-water surface. Thus modified or contaminated, the air-water surface tension is reduced to a moderate extent, varying with the character of the oil and the temperature; but after a certain minute quantity of oil is present, possibly 1/1,000,000 or 2/1,000,000 of an inch, further change in the surface tension is relatively small. The power of attachment of the bubble to the mineral varies, as we have seen, with the amount and kind of oil, but in general range of a 30 milligram galena cube. In this case the attachment is direct to the bubble as a whole, and possibly there is also attraction through the oil film to the air, as explained this morning.

Fourth, the presence of an oily mineral frothing agent in the bubble or in the water also modifies the

water in the sense that the subdivision of the air is rendered easier and coalescence of bubbles is retarded, reduced or entirely prevented.

Fifth, a soluble mineral frothing agent probably coats a mineral particle and a bubble of air in a different manner. It certainly does modify the water, in the sense that has been given in No. 4. Usually the soluble mineral frothing agent does this to a far greater extent than the oil. The power of attachment is also reduced with the soluble frothing agent to about a 30 milligram galena cube. In this case the attachment is direct to the bubble, if not directly to the air.

Sixth, the oil film of Nos. 3 and 4, possibly also the adsorbed films of No. 5, promote or facilitate the quick attachment of the mineral to the bubbles, even though such films have reduced or modified the power of attachment to the bubble. Accompanied by electrolytes—acids, alkali and salts,—in the pulp, these films give a controlled affinity of air bubbles for the metallic particles in the presence of a frothing agent, and if given opportunity, produce a stable froth of the so-called armored bubbles.

Seventh, the addition beyond this minute quantity of oil produces an excess of oil; whether it is added to the mineral or to the bubble, provided they are in contact. If there is enough of it, it will collect on the surface in the form of lenses or globules, thickening the film, and thereby separating the modified contaminated or double surface to a visible extent. When sufficient excess oil is thus added we reach the upper

William Mason Grosvenor.

limit of the oil quantity, which is capable of producing the effect of direct attachment, an effect obtained with a minute quantity of oil. Beyond that point the mineral, or even the oil alone is liable, in agitation, to be swept off a bubble and carried away. Under the conditions last described the mineral no longer directly attaches to the bubble, and that leads to a distinction between an oil froth and an air froth. I will describe an oil froth as an aggregated mass of globules and films of oil and water, with bubbles of air, having the mineral contained in the oil, and from this froth the air bubbles are likely to slip away because of their ability to move through the oil upwards; and the mineral is likely to slip away downwards through the oil and through the oil-water interface, and drag masses of oil with it. The power of attachment of the oil globules in the water for mineral (making the oil globules, just as we made an air bubble by allowing oil to rise up under a bubble holder) is often less than 5 milligrams of galena cube.

~~THE WITNESS: With No. 8~~ Eighth with amounts of oil such as we were speaking of that visibly separate the air-oil film on the inside from the oil-water film from the outside, the mineral particles if small are free to move around each other, to gather in masses at one or the other side of the oil mass that is surrounding the bubble and produce a heavier drag on the weak oil link or oil neck which now alone attaches them indirectly to the bubble.

9th. Some oils are non-frothing, kerosene for ex-

ample, and are substantially inert so far as No. 4 is concerned (the modification of the interaction of air bubbles and water by the presence of the oily mineral frothing agent). Some of these, among them kerosene, are less detrimental in respect to No. 7 (the effect of further addition of oil beyond the minute quantity) ~~or~~ and No. 8 (the readiness with which particles gather in sufficient amounts to tear off the oil neck). Violent agitation tends to emulsify some of these oils, among them kerosene, so that they may be carried in the circuit water to be entrapped in the settling concentrate of the gangue slimes. Air bubbles which may be produced in great quantity by unnecessary agitation can ~~de-~~oil mineral particles and uselessly add to the quantity of the froth. Great violence of agitation subdivides the oil globules and makes them smaller so that original overloading of bubbles with mineral particles is reduced or retarded and more useless oil can be put through the system.

Tenth. It appears throughout the above that mineral frothing agents are not of necessity oils or oily in character, so that it is a mere incident that oils are also some of them mineral frothing agents if used only in such minute quantities that they no longer act like oils in bulk, and do not show the properties that are exhibited in the oil froths. Also that what I have called an oil froth is indeed radically different from an air froth. While it may be difficult, if not impossible, to draw a sharp line during the transition stage, particularly where an excess of inert oil is added and agi-

William Mason Grosvenor.

tation and aeration increased, the technical effect changes somewhere, dependent upon conditions until finally all traces of air froth have been made to disappear.

Q. 26. I call your attention to the testimony of Professor Beach wherein he is considering the action of a captive bubble or a bubble in a bubble holder and wherein we find the following, 128-Q. "Now what would happen if the bubble holder were lifted upwards—" it was the case of clean sulphide mineral—"A. The force of surface tension has a certain component. If the particles of sulphide were greater than the total value of the upward pull of surface tension, it would not be lifted from the bottom, but the bubble would stretch out and would finally neck off and we should have a complete spherical bubble attached to the bubble holder, and probably a little watch glass bubble attached to the surface in case the sulphide was too heavy. If the sulphide particle was not, then I should expect that the bubble would lift to the surface through the water." What have you to say on that testimony?

A. This is a substantial confirmation of statement No. 1 that a clean air bubble in water, captive, in unmodified water will attach and carry mineral particles to the surface, particles of a weight roughly corresponding to the surface tension of the air-water surface acting around the line of attachment of the bubble to the particle. Beyond that, it is a demonstration of theorizing as to what will happen which my

own observation does not confirm, because while the bubble may split and a portion of the bubble remain with the particle, I have not seen a watch glass shaped residue of air left on the particle; and the almost invariable action is that the whole bubble peels away from the particle precisely as we saw it a number of times in the experiments just shown.

Q. 27. Professor Beach, in his testimony, described experiments with an aluminum ring floating upon the surface of the water and carrying considerable weight when clean and failing to carry that weight when slightly oiled, in answer to question 109, his description having been given at some length. Have you anything to say as to that?

A. That similarly confirms the general statement above quoted from conclusion No. 1 and further has an application where he applied oily material to it, in confirmation of some of the later statements.

Q. 28. I call your attention to the answer of Professor Bancroft in answer to Q. 132 which I will hand to you without reading in the record and ask you what you have to comment upon that testimony?

A. With the statement that so-called minerals, zinc sulphide and lead sulphide, do generally adsorb air markedly, I am not at all disposed to disagree. It confirms clearly the statement that finishes my statement No. 1 as to the direct attachment of minerals to the bubble if not directly to the air. I think it is possible for just some such reason that the mineral is not readily wetted by water and Professor Beach says

that there is no reason why we should not have direct connection between the air and the mineral; that he would not think of disputing it.

Q. 29. And when you have finished with that I will ask you to include also the following question, ~~133.~~ 133 and the answer, for your comment?

A. Continuing with 132 it is of course true that we may not have direct contact between the air and the mineral. We have seen that under certain circumstances we do not. But, insofar as he means that there can be no influence of the air on the mineral through a minute film of oil, I cannot agree with him because there is every indication that there might be and at the same time I do not know that there is. With regard to question 133 where mineral particles are apparently lifted by air, is it certain that that is really happening? It is true of course that if the mineral particles are sufficiently dirtied or covered over with oil, it is not true. My experience indicates that if that is the case, the attachment of the mineral to the bubble is extremely small, that the intermediate stage of reduction of the thickness of that impurity coming between the air and the bubble when it reaches a minute amount, the mineral particle is in position as indicated in diagram No. 2, where both surfaces or interfaces (the interface between the air and the oil and the interface between the oil and the water), are in position to act upon it and attach it very much more firmly to the bubble. The mineral particles that I have handled in determining the limits of these at-

tachments have been carefully either preserved in their original cleanliness or cleaned, because experience quickly taught me that any reliable results necessitated that. Where we have used the aluminum particles, some precaution had to be taken if we desired to have a clean particle. The galena particles, where extreme precision was required, had to be as I say very carefully cleaned, and we identified—checked up the results by breaking galena under water in order to insure the absence of false films of impurities that might have come down upon the galena or been attached to it in handling or in some other way. So that I agree with him thoroughly that it would depend on the degree of care with which the experiment was carried out. And his testimony there agrees entirely with our conclusion.

Q. 30. Professor Beach has testified in answer to question 254 as follows: "If this oil was kerosene or creosote or pine oil at the instant of contact of the oil point with the surface there is usually seen a flash of oil over the surface—seen by reflected light—you get the colors of the different films; the experiment is readily visible in that form." What have you to say as to that?

A. It confirms the first part of what has been stated above as conclusion 3, that the oily mineral frothing agent can be made to flash quickly, be shown to flash quickly, a film of infinitesimal thickness over the surface of the bubble; and anyone used to observing bubbles can see that same film flash over the

No. 3081

United States Circuit Court of Appeals

For the Ninth Circuit

MINERALS SEPARATION, LTD., ET AL,

Appellees,

vs.

BUTTE & SUPERIOR MINING COMPANY,

Appellant.

Transcript of Record

Volume 8

(Pages 4213 to 4888, Inclusive)

UPON APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF MONTANA

McKee Ptg. Co., Butte, Mont.

William Mason Grosvenor.

bubble; though it is more easily observed over a level surface of water in a pan.

Q. 31. I call your attention to another portion of this same answer of Professor Beach's as follows: "The physical phenomenon which happens there is a spreading or adsorption of the oil over the interface, and I have no question that there is a layer of adsorbed oil upon the interface of that bubble just as here we find that when the experiment was completed we have an oiled layer or adsorption film in the upper figure." What have you to say as to that testimony?

A. Except for the uncertainty that there may exist with regard to the thickness of the layer, I do not question it. It confirms the general statement in the first part of conclusion No. 3 as to what happens when the oil comes in contact with such an interface. The oil spreads over and modifies its characteristics. But, insofar as that may be taken to mean a hundredth of an inch or a foot, I wouldn't call that an adsorption layer because it is not my idea of an adsorption film.

Q. 32. Professor Beach in answer to question 256 said, referring to the lecture by Lord Kelvin, "in that lecture he has carried out a calculation to show what the least thickness might be. The upper limit, the maximum thickness there one can hardly state. If you put on a large drop of oil, ~~and~~ a certain amount~~s~~ of it spreads over the surface and the rest of it gathers together in a little lens-shape figure, and if you add more oil the lens increases its diameter, until the whole surface would finally become covered to any depth." What have you to say as to that testimony?

A. That again confirms the same part of conclusion 3, with the comment that these results were largely based on calculations or theory rather than on direct measurements as I remember them. But there are later results that are extremely accurate and they very closely confirm the original calculations, defining however more clearly the lower limit of complete filming, the upper limit of complete filming without lenses, and then the slightly higher limit of forming of a stable film with lenses. Either one of these films would probably be greater as the—either one of these films would probably be regarded as an adsorption film if one wanted to call it that and use the word in that sense, but that the lens of oil or globules of oil sticking up on the surface of that film and exhibiting the properties of oil in mass should be confused with the adsorption layer seems to me unwise, would lead to incorrect conclusions as to the action of that oil.

Q. 33. I call your attention to Q. 138 and the answer in the testimony of Professor Beach, and read the following question: "My opinion is that this angle would be smaller than in the case of pure water against a sulphide, and that the lifting power of this bubble would be diminished." I call your attention to that question and answer for explanation and comment?

A. I do not feel altogether like accepting the statement with regard to the angle as being a sufficient basis for a conclusion as to lifting power. There is a closely qualitative relation apparent between the two

P. 4215, L. 3, insert "early in my examination of this phenomena I was fortunate" after "but"

William Mason Grosvenor.

and I think one might use that as perhaps as a general guide, but enough to see some manuscript pages of a book that was started out to be written on the subject of contact angles, and there came to be such a wide divergence between the contact angles under different circumstances (what way the particle was moving and its shape and so on) that the author introduced "hysteresis of contact" into the equation ~~question~~ to try to explain the phenomena and finally did not publish the book. I think that is fairly well illustrated by the statements that were made with regard to the wetting of glass by mercury. If the glass bubble, to which I think it was Professor Beach referred, be brought down to the surface of the mercury and a tiny particle of glass be floated on the surface of the mercury, according to the movement of that glass the particle floating on the surface will be either rapidly pushed away from the point of contact or drawn to the point of contact, just as we can see the aluminum particles floating on the surface of the glass drawn to or pushed away from anything that bends the surface down or pulls the surface up. Now, when it pulls the surface up we have one contact angle; when it bends the surface down the consequence is that we have a different contact angle and I am inclined to agree with Professor Bancroft when he says that he does not regard contact angles as accurately measurable. In fact in his mind there was some question whether there was any such thing; but insofar as the contact angle is an accurate measure of what is going on, I entirely agree with Professor

Beach's conclusion as to its effect on the lifting power. In fact, that confirms the latter portion of conclusion 3 where we saw that with this modification of the contact, ~~of~~ the air-water surface tension is reduced to a moderate extent, ~~and~~ The ring experiment which has been spoken of, the floating ring greased with one kind of material or another, confirms the balance of the statement, "varying with the oil and the conditions," and I would think we will find indirectly implied in the existence of anything like a reduc~~ing~~ed contact angle, the confirmation of the statement that further reduction of the surface tension is relatively small.

Q. 34. I quote the following from the answer of Professor Beach to question 164: "The surface tension of a liquid film, that is, with an upper and lower surface, a liquid film does not depend on the thickness as long as that thickness exceeds a certain small value." What have you to say as to that?

A. That confirms the proposition of conclusion 3, "after a certain minute quantity of oil is present, further reduction of the surface tension is relatively small."

Q. 35. Continuing in answer to question 164 Professor Beach says: "Do you want that thickness? Q. 165. Yes." And then follows this statement: "I can only quote from memory as I haven't my notes with me. I have represented here (drawing a diagram on paper) a molecule of any substance, and here is another molecule of the same substance. Then, the limit of molecular range, I mean the greatest distance which

William Mason Grosvenor.

we can separate these molecules and still have this one act upon that, that distance 'd' is, I believe, one twenty thousandths of a millimeter." What comment have you to make as to that testimony?

A. That would seem to me to confirm one of the facts essential to my statement that there might be action between the air and a mineral even though minutely oiled. That appears to be a statement of the limiting thickness of a layer of oil which will interfere with that interaction, and that as being approximately two millionths of an inch, which we spoke of this morning as being the length of action of materials, one on the other. Since the thickness of the oil layer is less than that you might expect to have direct action between air and the mineral particles. If, according to the assumption made by Professor Beach, there were an admixture of air and oil at the surface and oil and mineral at the other surface, I don't think these layers of admixture are anything like the same thickness and so I don't think they make much difference.

I read the following testimony of Professor Beach, Q. 174: "I would like a definite statement from you as to whether or not the affinity of air for metal is utilized in the froth flotation concentration of ore. A. In the agitation froth process, or in the pneumatic froth process it is not. It is not, except in as far as there may be air adsorption in this interface. 175-Q. That is, there may be air adsorbed at the oil adsorption interface? A. There may be air adsorbed at any place where air is in contact with another liquid or an-

other solid, but in my judgment air plays a relatively insignificant part." What have you to say as to that testimony?

A. First, that it indicates the presence in Professor Beach's consideration of precisely the same conceptions of direct action between the air and the mineral that may be effective with very minute layers of oil. But, more important than that ~~this~~, it seems to me to indicate that he has in mind (when he is speaking of air froth flotation) a thin film of oil, of such thickness that it cannot be called a layer, but would exhibit the properties of a film and of such thickness that the difference of surfaces on the inside and the outside of the layer might very well be effective on the property of the layer, if you call it a layer. I should prefer to call it a film. It is in substantial agreement, it seems to me, with the latter portion of conclusion 3.

Q. 36. I call your attention to question 63 in the testimony of Professor Taggart, that question having been propounded by the court, it being as follows: "You say the particles are in the film of oil surrounding the air" and particularly to the part of the answer, "And there can be no question ~~statement~~ of the attachment of air for the particle itself," and further on below: "By examining these froths it can be seen that air is not in contact with the solid particles at all and they come to the surface in the bubble film." What have you to comment as to that testimony?

A. In the first place I think Professor Taggart was speaking of the film which he had made with a

William Mason Grosvenor.

considerable quantity of oil. If I recollect properly he testified that he had not observed films made with extremely minute amounts of oil and I want to call attention to the fact that the film which he showed us contained at least twice as much liquid as the film of a bubble because by taking a whole bubble, as I understand that he did and puncturing one side of it to break it, the liquid from the bubble would draw together into the single film that was left at the bottom, the solid particles being left rather in contact with the ring so that in observing such a film we would be looking at twice the amount of liquid, without twice the amount of solid material, and we would expect it to be very much more wetted. That, however, is minor because the statement as a whole I think fully confirms my conclusion that even with the oily mineral frothing agent in minute quantities or in considerably large quantities the attachment of the mineral is direct to the bubble in the sense that the bubble is made up not merely of a piece of air but of the dynamic film; the film that surrounds the bubble and that the particle in the layer, in this film, are attached to this film directly. It confirms the statement of direct contact.

Q. 37. Professor Taggart has testified in answer to question 61 as to his examination of bubble films under the microscope: "In such examination I have found that in freshly formed films a very large majority—and by that I mean in the proportion of ten, or twenty, or thirty, or forty thousand to one—of the particles present in the film, are entirely within the

bubble film." What have you to say as to that testimony?

A. That these bubble films if made in the way that the other one was made, would have a great deal more film material but that this would not be an important difference because the major effect of the statement is, after all, merely to state that the mineral particles under these circumstances are directly attached to the films of which the bubbles are made. They are directly attached to the bubbles.

Q. 38. I read to you the following from the testimony of Professor Bancroft, 140 Q. "In your judgment would it be proper to call such a froth an air froth, meaning thereby that the air is attached directly to the mineral particles? A. It would not be proper to call it that, because that is not what happens; and it is a great deal better, it seems to me, to stick to the facts." What have you to say as to that testimony?

A. That we have not been concerned mainly with the necessarily direct attachment of the air to mineral, which is the only basis on which that criticism could properly be made. If we consider that the real essential of the conclusion is the attachment of mineral to the bubble, I don't think Prof. Bancroft would have made that criticism. His other testimony all confirms the opinion that, taking the sense of "bubbles" in the broad, practical meaning, he would certainly regard the mineral as attached to those films; in fact he called them adsorbed into the film, in which case they must be attached to the bubbles. It is rather splitting hairs to divide the bubble from the air in the bubble.

William Mason Grosvenor.

Now, the particular froth which he referred to is described in 139 Q., as made by agitation at about 1800 r.p.m. of 80 c.c. of water at 70°, 16 grams of Broken Hill tailings, and six c.c. of 20% sulphuric acid and one drop of oleic acid, which would be between one-tenth and two-tenths of a per cent of the ore, and as to that he was asked whether it would be proper to call it an air froth, and he said it would not. What have you to say as to that?

A. Well, in any reasonable interpretation of the expression, air froth, it certainly would be. Even in the precise scientific definition it would be a froth in which there was substantially nothing but air and mineral. In the most detailed and accurate scientific examination of the froth you would find something less than 1/100,000 of an inch of oil to be distributed on the surface ~~of~~ that mineral, and that, if any of the oil be assumed to go anywhere else at all, we would be down in the neighborhood of the ranges where the direct connection between the oil and mineral would be expected to have been at the admixture of the interface—at the adsorption of the interface. So it would be characteristic to call that air froth; it could be hardly called anything else.

Q. 39. I would here ask you what you have to say as to the statement of Prof. Beach, that air performs a relatively insigniifcant part in froth flotation, as well as the statement of Prof. Taggart along the same line?

A. That I can not agree with them at all, because

it is not merely a question of the buoyancy of the material. They have got nothing even remotely resembling the characteristic air froth, If they use some material which is not effective, like the air to catch the mineral particles in these minute layers of oil at an interface, between those layers, or within those very minute layers ~~the mineral particles~~. In other words, that in the absence of air and of a large predominance of air, there would be entrapment of the mineral in the oil instead of any effective attachment of the mineral to the air bubble.

Q. 40. Professor Beach, in answer to Q28 and referring to his experiment in a beaker with red ink and water and oil, referring to the interface, says: "The striking thing about this is its viscosity and possibly lower surface tension. This is the fabric of which the bubble film in the flotation process is made up." What have you to say as to that testimony?

A. That it again confirms the statement of direct attachment, and in view of what we have seen in the experiment, serves to mark off the difference between direct close attachment of the mineral to the bubble constituted of such a layer, as compared with the indirect, loose and ineffective attachment of the mineral to the bubble by a long neck or a considerable mass of oil. The force exhibited by such a layer is far more effective—incomparably more effective, I am tempted to say, than the cohesion by a mass of oil, if that be the only connection between the mineral and the bubble.

Q. 41. Professor Beach, in his answer to question 8, describing an experiment which I believe you have

William Mason Grosvenor.

in mind, says: "The sulphide would be above the surface; it would be elevated by these little balloons, ~~through~~ to which they stick." I hand you the testimony in question and ask you for your comment thereupon.

A. In order for the bubble to carry the mineral above the surface, as we know that it does in the characteristic air froth, in making the characteristic air froth, it is to my mind essential that the mineral particle be attached directly to this film or layer, which, as Prof. Beach has said, really constitutes the bubble. However, these citations are substantial confirmations of the distinction between an oil froth and an air froth, and confirmation of the statement that the mineral in the air froths is directly attached to the bubbles.

Q. 42. I read you the following from the testimony of Prof. Bancroft, his answer to question 22: "When you add a practically insoluble oil to water, it is usually adsorbed by the water, and spreads out as a thin film; that this film gives you largely increased viscosity, as was shown the other day, and since this is a surface film which has more viscosity than the mass of the liquid, you will get foaming." What have you to say as to that testimony?

A. That seems to ~~be~~ me to point a distinction which I am inclined to draw between Van B~~[illegible]~~ommelen's original definition of adsorption, and the mere spreading of a layer of oil on the surface of the water. However, the general tenor of the answer is the result of drawing a distinction between soluble and insoluble oils. The action of insoluble oils—at least the insoluble portion of

the oil—being distinguished from the soluble portion. The statement that there is a largely increased viscosity, may apply, and in my opinion does apply to the true adsorption layer—and by that I mean the adsorption layer in the sense in which I have attempted to use it throughout the case—for the condensation line, rather than a layer of mixture. But that that viscosity is effective through any considerable distance outside of the film, or either side of the film, seems to be very well disproven by Prof. Taggart's experiments, when he added a small amount of oil to the surface of the liquid, and showed that rotation of the spider did not materially affect any movement of the floating chip; but as soon as a little dust was sprinkled on the surface, there seemed to be a connection between the chip and the spider. If the film had any substantial or any considerable viscosity—the film between oil and water—it seems to me it would have effected very much more movement of the chip. The movement there would perhaps be sufficient to—would perhaps be seen to take place in the oil above that film, without necessarily affecting any considerable area of the film as a whole. The statement, however, agrees, as far as I can judge it as definite—it agrees with my conception of what occurs when those extremely minute films go down and include a particle of mineral. The films, owing to their higher viscosity, give the direct attachment between the mineral and the bubble, and serve to prevent the minute particles of mineral moving about in the surface of the bubble, collecting at one side and

P. 4224, line 13, after "and" insert:
"floated his magnetis spider on the sur-
face of the liquid and"

P. 4225, line 19, after "walls" insert: ", it can be made more stable by adding something or other which will increase the viscosity of the cell wall."

William Mason Grosvenor.

getting away from the bubble by drawing down all of the oil to one side of the bubble mantle.

As far as the statement of foaming is concerned, it seems to be simply a confirmation of the conclusion we have given as conclusion No. 4, that "the presence of oily mineral frothing agents in the bubble or in the water, also modifies the water, in the sense that the subdivision of the air is rendered easier, and coalesence of the bubbles is retarded." In order to have the formation of that foaming I think it is necessary to make the subdivision of the air easier than is the case with pure water, and to retard, if not wholly prevent, the coalesence of those bubbles, once formed.

Q. 43. I call your attention to Q. 39, and the answer in the testimony of Prof. Bancroft, as follows: "How can a froth be made more stable? A. Since the instability of the froth is due to the low viscosity of the cell walls, or of the films constituting the cell walls." What have you to say as to that testimony?

A. The film constituting the cell walls is another way of speaking of direct attachment to the bubble. Clearly what is in that film is in the bubble. But, broadly speaking, the statement is again a confirmation of the conclusion that the oil, acting as a mineral frothing agent, modifying the action of the bubbles, makes it possible to produce a froth.

Q. 44. Now, I would like you to do an experiment if you will, using an air bubble in an all oil medium, and observe the different lifting power upon small mineral particles.

William Mason Grosvenor.

A. I have here one of the glass cells, which contains some pine oil, and, as was the case before, we will endeavor to make clear the connection between air surfaces and mineral, in the presence of considerable amounts of oil, in this case using a large quantity of oil, half filling the cell, and putting mineral into the oil, allowing it to rest on the bottom of the cell and approaching it with the bubble, to see what happens.

Again we will take the minus 200 mesh mineral, which, as can easily be seen from the soiling of the paper, contains dust of almost infinitesimal size, and we will place some of that with forceps at the bottom of the cell half full of oil. Some of it drops off the forceps before the forceps touch the surface, and extremely fine illustration of just what I want to emphasize occurs. The mineral goes to the bottom. The air leaves the mineral and goes back up to the top. The air could not adhere to the mineral under those conditions. Putting a bunch of the minerals, enclosed in the ends of the forceps, at the bottom of the cell, and opening the forceps and raising them, we see that substantially no air was left inclosed in that mineral by the time it got to the bottom of the cell; another clear indication of the rapidity with which oil slides in between mineral and air; and if there is a sufficient amount of oil to separate them, beyond their range of co-operation, and in an interaction, there is a complete divorce of the air and mineral. In order to enable us to observe a little more clearly both the inside and the outside of the bubble, I have used what might be called

William Mason Grosvenor.

a sectional bubble holder, that is, a bubble holder which has one one side a piece of ten-thousandths inch microscopic cover glass, welded into the side of the bubble holder, to give a flat face and to enable us to bring the bubble directly against the side of the cell. Taking such a bubble in the pine oil with which the cell is half filled, and approaching the mineral resting on the bottom, you can observe through either side of the cell that there is apparently no gray surface or no indication of contact between the air and the mineral; in other words, that looking through two optically plane surfaces, the air comes in contact with an oil layer resting on the mineral, but does not succeed in taking up the mineral at all. We may agitate it there as I am doing now for some time, and then raise the bubble, bringing the bubble over to the side of the cell, and I think you will observe that there is no evidence whatever of any mineral attached to the bubble; that ~~the~~ if the bubble is looked at underneath, a beautifully clear and pellucid surface is seen, to which not the slightest partice of this mineral is attached.

Q. 45. That is to say, under these conditions even the finest particles of metalliferous mineral can not be attracted or held by an air bubble; is that the statement of what you have demonstrated?

A. It is.

Q. 46. BY THE COURT: Did the air touch the mineral?

A. The air touched the mineral as far as we could touch it, as far as air is capable of touching mineral in the presence of excess oil.

Q. 47. BY MR. WILLIAMS: Did you press the air bubble down on to the mineral?

A. It was pressed down on to the mineral repeatedly, again and again. Had the mineral been in water, there would have been an instantaneous gathering of that same mineral on the surface of the bubble, as can of course be easily seen in another vessel, using the same mineral and any kind of bubble holder. It is somewhat difficult to get such fine mineral to go through the air-water interface; in fact very little of it has gone down to the bottom.

Q. 48. MR. SHERIDAN: You did not put it down with the forceps?

THE WITNESS: No, but I will be delighted to do that, because it makes no difference how the mineral gets to the bottom. We did that before, and we found the air very unwilling to leave it; so much so, that the mineral would not separate from the forcep ends, and you see, it is difficult to put the mineral in there; that is precisely what you saw before, and your attention was called, when we finally did get the mineral to fall off, that it was not held as a point, but what might be called a bubble full of mineral; and when that is approached with a bubble holder full of air, we find that there is a very great readiness of that bubble to take up the mineral. Spreading the mineral out somewhat on the bottom where you can get it, and blowing aside the mineral that has collected to some extent on the surface, we produce a bubble which is substantially clear of mineral, and we go down upon the finely di-

vided mineral, picking up first an aluminum particle which is lying in the vicinity, and at the same time picking up quite an aggregation of fine mineral, galena particles, that are present on the bottom.

Whereupon further hearing was adjourned until Wednesday morning, May 9th, at 10 o'clock a. m.

Wednesday, May 9th, 1917, 10 a. m.

DR. GROSVENOR,

DIRECT EXAMINATION Resumed

BY MR. WILLIAMS:

Q. 49. You have stated your conclusions as to air froth flotation, and I have called your attention to certain parts of the testimony of the scientific experts for the defendant. I wish you would continue upon that subject without direct interrogatories, giving your views and any explanations of that testimony, in a continuous answer.

A. Conclusion No. 5, given yesterday, as to the action of the mineral frothing agents, in coating the mineral bubbles and producing the frothing action will be found confirmed in Dr. Taggart's testimony, page 915, question 199. He puts it that acetic acid has the same selectivity for mineral—for metal, because, as he reasons it, it must have if the sulphide particle concentrates at the surface of the air bubble in a way similar to the way in which it concentrates at the surface of the air bubble when oil is used.

Also Professor Bancroft, question 131, page 1118; but in my opinion (expressed in the conclusion) there is a difference not recognized in Prof. Taggart's statement, which Prof. Bancroft does recognize. "The oil layer you have is ~~this—~~ different, because it does not come out as oil ~~in~~ you, have a relatively oil rich solution in contact with the air ~~surface~~ throughout, ~~but~~ and you do not have any contact between the solid particles and the air." That is a denial, apparently of the misunderstanding that there has been claimed all the time, direct contact of necessity between the air and the mineral, rather than between the bubble and the mineral. This is the contact with the bubble which I regard as existing.

Professor Bancroft, page 1055, question 18, speaks of the surface film which is more viscous than the mass of the liquid, but the absolute viscosity is very low; and then he proceeds to explain on page 1048, (Q9) the relation between frothing and this viscosity. As further confirmation by Professor Bancroft as to the contention of our statement in regard to the action of soluble mineral froth ing agents, he goes into details on pages 1050, 1051 and 1052, Q12-14 and the explanation to a greater extent on 1049, 1050, and 1051 Q11-13—(that is the method in which he conceives it was carried out) but the general description of the action is entirely confirmatory of the conclusion. All through his testimony we find again and again repeated, so many times that it did not seem desirable to take it up and emphasize it in each case, the direct attachment, provided the understanding be that the attachment is with the bubble and not necessarily with the gaseous filling.

William Mason Grosvenor.

Professor Bancroft also partly recognizes on page 1119, question 132, the possibility of air entering into the oil film, and mineral entering into the oil film to the extent of the adsorption film on each side, which would make it quite conceivable at any rate that there should be an action between the air within the bubble and the mineral hanging on the surface of it.

THE COURT: These bubbles you made yesterday were in distilled water?

A. Some of them were and some of them were in modified water.

Q. 50. How do you describe the bubbles there as distinguished from the air? You speak of the mineral attaching to the bubble but not to the air.

A. The bubbles in any common understanding of it, any ordinary understanding of it, and in my opinion in the most accurate explanation of it, would not be the mere mass of air present within a film, but would be the combined whole, a filling of air in a sack of films; because the air by itself unless enclosed in a film would not be for the purpose of our work a bubble at all.

Q. 51. THE COURT: But in the water you distinguish a film there, distinguished from the water?

A. In pure water?

Q. 52. Yes, what you had yesterday?

A. I think so without any question. A great mass of the testimony of the other experts is that at the junction between the air and the water there is at least one film. In my opinion there are ~~only~~ two. There is

a film of highly dense water on the outside which does not behave physically as the ordinary mass of water does and there is a film of highly condensed air on the inside which does not behave in every respect as ordinary free air does. In other words, there is in a sense there also a double film; but where I have referred to the double layer before I have been speaking of a layer on the two sides of the minute oil film. Perhaps I should say the interface on the two sides of the minute oil film. There again we have an interface which does not act quite like the ordinary oil in bulk, and on the outside, between the oil and the water we have another interface which does not act like either oil or water. Both of them have properties peculiar to matter tha I think we depend for all these phenomena involved.

Confirmation of conclusion 6 (without entering into just precisely what processes are I think that will be involved in the reading) will be found in Professor Beach's testimony, page 970, question 39, Professor Bancroft's testimony, page 1101, line 4 (Q117) That is also interesting as a confirmation of this direct attachment to the layer, because he speaks of his solid adsorbed by the oil layer, by the oil-water interface or by the oil-rich solution. In other words, he agrees entirely with Professors Beach and Taggart in putting the mineral particle which is carried by the pulp, into that layer which is an essential part of the bubble. The portion of the conclusion of yesterday which affects the modification will be confirmed by Prof. Beach's testimony, page 1007, question 138, where it is recognized that

P. 4232, line 15, after "matter" insert: "in film, and it is on this peculiar condition of matter"

Prof. Beach regards the contact angle as expressive of that change of condition which we call modification, change in the action between two materials. A similar confirmation is found on pages 994 to 997, (X Qs 109, 110) particularly page 997. (X Q 110) Further confirmation of a part of the conclusion referring to action of excess oil, that is excess oil above the minimum amount, the action tending to take up these mineral particles and stabilize, what we call armour the bubbles, is found in Prof. Beach's testimony, page 959, line 18, (Q 20) and 961 and 962, (Qs 20-23) and also in Prof. Taggart's testimony, page 924, question 244, where he states that he regards the presence of the solid matter as far the most important part of the process of stabilizing. The particular portion of the conclusion to which this chiefly refers is the latter half. "Th~~is~~ese film ~~again has~~ give a controlled affinity"—by "controlled" we mean modified or restrained or aided; and by "affinity" we mean as defined, the tendency to get together and stay together—"of air bubbles for metallic particles in the presence of a frothing agent, and if given opportunity produce~~s~~ the stable froth of so-called armoured bubbles." The next conclusion with regard to the action of oil above the necessary quantity and approaching that quantity which separates the layers, and perhaps if carried on separates them to the point of injuring the attachment, will be found—such confirmation will be found in the testimony of Prof. Beach page 1043, line 10, (Rx Q 256) where he describes the formation of lenses; and the testimony of Prof. Taggart where he describes his film that he saw under the mi-

William Mason Grosvenor.

croscope, particularly when it is remembered (as pointed out yesterday) that he had about twice as much liquid on one side of the bubble, because in puncturing the one side of the bubble the liquid moved around to the other side and remained. That incident is an extremely good confirmation, as was pointed out yesterday, of the direct attachment, the action of the oil neck, where the amount of oil in the film becomes too great, ~~is~~ a well confirmed by Prof. Bancroft, page 1108, question 118, and page 1110, (Q 119) at the bottom of the page: "Since the thick film of oil—I am using "thick" without giving any definite limit~~s~~ to the size for a moment ~~—a film that is thick under those conditions~~ is not ~~so~~ stable, and consequently the oil will pull off—" and by the use of "film" I think Professor Bancroft was choosing his words well—"not extremely thick layer" but "a film that is thick under those conditions is not ~~so~~ stable and consequently the oil will pull off." On page 1110, question 119, Prof. Bancroft says again: "The air bubble will tend to pick up the oil globule (in the pulp), and the oil or some of the oil will pass around ~~to~~ in the interface between ~~the~~ water and air." Under the influence of gravity it will not tend to concentrate uniformly, but distinctly it will not be uniform, "and you will get more of the oil down at the lower end of the bubble;" and since a thick film is not ~~so~~ stable, "oil will pull off and you will have your air bubble with a ~~thick~~ thin film of oil around it and the rest of your globule~~s~~ of oil will be drifting around wherever fate ~~will~~ may take it."

Further confirmation of that weakness of attach-

William Mason Grosvenor.

ment will be found in Professor Bancroft's testimony, page 1109, question 118; also page 1112, question 122, where, in criticising the statement that the mineral was attached directly to the air as he understood it, he says: "I should prefer to draw the conclusion * * * * that the cohesion between oil and oil was less than the adhesion between ~~air~~ oil and ~~oil~~ air." In other words, in my own language, the bubble ~~uses~~ has, ~~when~~ attached to an adsorption layer of oil, a cohesion layer of oil, and the mineral, ~~when~~ is attached to an adsorption layer of oil on the other side—more properly film—~~it~~ should be used in the first and last cases.

Now, according to Professor Bancroft, if a strain is put on that, we have nothing but the weak cohesion of the oil between those two weak layers to hold the thing together.

Confirmation of conclusion seven will be found further in an indirect way in Professor Beach's testimony, page 1024, question 192: "Q. And the more oil you put in, the better the results, is that right? A. You will ultimately arrive at bulk oil flotation. You would not have any bubbles if you put in oil enough." The statement in regard to bubbles is interesting, in view of what we saw yesterday in the way in which the air bubble leaves mineral in the presence of a quantity of oil: I speak of quantity as distinguished from a film.

Further confirmations of the conclusions offered yesterday will be found in respect to conclusion No. 9, where Prof. Bancroft speaks of kerosene being

a non-frothing oil; in other words, inert in at least one respect, page 1057, question 51; question 24; page 1066 question 50; all of these are in regard to the action of kerosene. He further says, bearing on this question of the quantity of oil which attaches the mineral to the air bubble: "Consequently the kind and nature and amount of aeration ~~air ratios~~," as I get it from the record—"will play a very large factor in determining what ratio of oil to ~~and~~ mineral you can use safely." Not what is necessary, what seems to have been the thought—the thought throughout the testimony seems to have been how much you crowd on without doing damage. That is found on page 1108 (Q 118) ~~at the bottom.~~

Now, in regard to the action of the air bubble, that was very clearly shown yesterday in bubbling a continuous stream of air under water over the oil, practically until all the oil was removed by the bubbles down to the point where the particle would not only lift by the captive bubble, but would lift by the free moving bubble. Prof. Bancroft says, page 1110: "Again the air bubble will tend to pick up the oil." The same quotation was used before, but it has a somewhat different bearing here, bearing on the question of the de-oiling of the bubble; question 119. The other has a somewhat similar bearing, page 1109, question 118.

Professor Taggart strongly implies the same thing, if it is not clearly stated, when he says (Q 55): "Therefore if you increase the degree ~~amount~~ of agitation it will be necessary to increase the amount of oil that is to be used." I don't know how necessary it will be, but it will be possible to do it.

William Mason Grosvenor.

Question 47, Professor Taggart, in reply to the question "What is the effect of the emulsification of oil—?" answered: "The idea of such agitation is to break up the oil into an extremely large number of extremely small particles." That is again a clear confirmation of the part of the conclusion which indicates that by breaking the oil up very fine it is possible to very largely overcome the dangers and difficulties found when you overload a particular particle with oil of any size. One of the things that I think the pictures will show rather clearly, is that when a mass of small particles gathers in an oil layer, they continue to gather until they reach the point where a load is applied to the oil-water surface, which is too large, and then they break through in a sort of reverse water spout. Now, that action is largely prevented if the oil is broken up into small particles, making it possible to add more oil without producing so predominant an amount of oil froth.

There are, as I have indicated before, a number of places in the testimony where a contradiction of the statement is based very largely on a different understanding of the words; but it is here and there based on a misstatement of the question under discussion. The best illustration of that, perhaps, is the question of direct attachment to the bubble. Another is Bancroft question No. 120: "Would it seem likely to you that these things you have stated might cause one to conclude that the air bubbles ~~did~~ do not directly attach themselves to the oil globules and have slight, if any lifting power" when attached?

There has been at no time a statement that air did not attach itself directly to the oil globules. One can hardly conceive of a more direct attachment than that sudden embracing—grasping of the whole circumference in a layer or film of oil. What was stated was that it does not readily—and it was seen yesterday and will be seen very much more clearly in the moving pictures, where a number of clear, precise images can be taken in a small part of a second, how the air bubble when brought in contact with an oil globule so frequently bumps it aside, and indicates very clearly that there is no readiness or quickness of attachment. Before it breaks through, the intervening layer of oil seems to snatch the bubble, and fasten all around it.

Another case is question No. 137: "Do you consider the proposition correct or incorrect that the fundamental principles of ~~air~~ flotation are air entrainment and the increased affinity of the air for the metallic particles in the presence of a frothing agent." Whereupon Prof. Bancroft endorses the air entrainment as he understands it, criticising the use of the word, but not the idea, and then says that the statement that affinity is increased, is very wrong. As a matter of fact there has been no suggestion that affinity was increased, in the sense of an increased holding power or power of attachment. The ease of attachment has been testified to by the other witnesses, and in fact it is the adsorption film that they have all contended that produced the attachment at all.

William Mason Grosvenor.

In conclusion, both commenting on the conclusions that have already been advanced and on the testimony, I would prefer to avoid theorizing on what happens or what might happen if what does happen didn't happen; the facts can all be made visible in one form or another, and the distinctions that are drawn should not be too fine. The distinction between an oil froth and an air froth, or perhaps we should say between a condition of oil and minerals—the air and mineral in an oil froth and an air froth—These are not imaginary distinctions, and are not taken down to the vanishing point of an extremely minute film. It is not my desire to overlook any pertinent scientific fact or to gloss it over. The statement in regard to why mineral wets with the first few millionths of an inch of oil surface, is interesting; as far as I can judge it is something of an explanation—at least it enables us to conceieve what could happen. At any rate it gives us another name for our ignorance when we call it adsorption; but unless the differences or similarity between the processes of air froth flotation and the bulk oil floats, aided by entrapped air, are something larger—something more tangible than the adsorption layer, that it will be difficult to recognize with an ultra microscope, and in dealing with which we must seek the aid of theory and a vivid imagination—unless the thing that causes the difference is down in that minute range, I conceive it were better simply to say that mineral wets, that the oil spreads a film over the bubble, and deals, as Professor Bancroft recon-

William Mason Grosvenor.

mends, with the facts rather than the theory. Those differences are the only similarities that I can find that the experts for the defense have been able to produce between the air froth and the air floated bulk oil conditions, that is, some subtle physical chemical laws, which continue to act throughout all ranges of oil, whenever the materials come in contact, but act through practically no range of distance; and it seems to me the essential phenomena with which we are dealing are phenomena which must occur at tangible distances; in fact there is testimony by the other experts to the fact that a monomolecular layer would be entirely inefficient for flotation purposes. They rather contradict each other there, when it is testified that a single molecule in a ton of pulp would float a single molecule of mineral, but the practical sense of the thing is agreed. These physical chemical principles I do not deny, but it seems to me that they make no difference. What happens within an adsorption layer a millionth of an inch thick is not useful to hold a particle of mineral indirectly attached by one-hundred~~th~~ or one-thousand~~ths~~ times that thickness of oil in the mass. There is nothing left but what Professor Bancroft has described as weak cohesion of the oil.

It is also interesting to note that the amount of oil shown—the point at which the limits are met, seems to have a connection with the experiment that we make in oil flotation, as it is called, and falsely called, in my opinion, because it is really and essentially air flotation—and it is more perfectly embodied the less oil we

William Mason Grosvenor.

have down to an extremely minute amount—so that if we try to increase the amount of oil above those minute amounts, my experiments have indicated that we run into trouble at just about the limits which are indicated by the necking off of the oil. I do not deny the possibility of the truth of all the fascinating theory, but submit that it has no place in court until related to actually observed results, and it certainly should not be permitted to obscure our clear vision of an obvious fact, capable of photographic record, the necking off or weak coherence of that oil layer which occurs when the amount of oil becomes a useless excess over and above the sufficient amount.

MR. WILLIAMS: Direct examination is closed.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 53. In your answer to question No. 10 on page 2133 of the typewritten record, you say: "When I speak of a film or layer I mean to try to make some distinction between the two, because a film is a thin layer, and while it is true that no major limit can perhaps be set to the thickness of a film, I should regard it as absurd to speak of an oil film, ~~an~~ or adsorption layer, anything like one-hundredth of an inch thick." Now, is it your intention to confine the meaning of the word "film" to an adsorption layer?

A. If by adsorption layer, you include all thicknesses of layers which can be reasonably expected to be affected by adsorption phenomena from either side—

William Mason Grosvenor.

X-Q. 54. Well, then, how great a thickness can you reasonably expect?

A. Pardon me; I do not want that to be regarded as the end of my answer; that was not "yes." I was going on to make an explanation. If we so regard an adsorption layer, I think the thickness of a film, scientifically speaking, where film is distinguished from layer, comes pretty close to being that thickness. In most of my testimony I have tried to use the word in that sense; but as is necessarily the case in the use of words, it has been used also to mean layer, to convey the idea of a layer which was sufficiently thin to be characterized by those properties of surface, without any precise distinction of whether there was a minute amount of excess material in between or not.

X-Q. 55. (Last question read): "In your answer to question No. 10 on page 2133 of the typewritten record, you say: 'When I speak of a film or layer I mean to try to make some distinction between the two, because a film is a thin layer, and while it is true that no major limit can perhaps be set to the thickness of a film, I should regard it as absurd to speak of an oil film, ~~an~~ or adsorption layer, anything like one-hundredth of an inch thick.' Now, is it your intention to confine the meaning of the word 'film' to an adsorption layer?"

A. Why, I have just stated that I did not mean to confine it to a single adsorption layer, or necessarily to a pair of adsorption layers on each side of

William Mason Grosvenor.

a film; that there might be some matter in between that pair of adsorption layers; but I meant to include down to the range so that the predominant properties were the properties of surface films.

X-Q. 56. Well, how do you ascertain what the predominant properties are, the properties of the adsorption film or adsorption films?

A. From scientific measurements, by observation of the behavior of materials when brought into contact.

X-Q. 57. Can you give an instance of some test by which things can be resolved into some degree of certainty?

A. If for instance and illustration, in diagram No. 2 where the surfaces are close together and both come down as one onto the surface of the mineral or where they come into actual contact—so far as we can see and judge by their behavior, in contact with the mineral. As Professor Taggart described it, displaced by the presence of the mineral in the under side and displaced by the presence of the mineral in the upper side. in the physical material he was examining, and if in moving or agitating or straining the particle, it seems to carry these films with it. I think it would be clearly observed that the particles were within the range of the action of the film, or film within the range of action of the particle.

X-Q. 58. Well, now, wouldn't that depend altogether upon the size of the particle that happened to be in there?

A. Naturally the extent to which the film was swung aside would depend on the size of the particle.

X-Q. 59. Are these surface adsorption layers that lie on either side of the imbedded particle?

A. Why, in the broad, general use of the word I should say yes. There are supposed to be differences of concentration there.

X-Q. 60. Now, you have said this relation between the surface of the film and the particle is of course related to the size of the particle. Well now, suppose we have a large particle, a forty mesh particle, that will just go through a forty mesh, and that is embedded in oil and film and shows the projection on each side as the interaction between the particle or the film or layer, whatever you call it, would that be a film in the sense you use the word?

A. I do not quite get the question clearly.

X-Q. 61. What I am trying to get at, doctor, is the measure you have given me seems to depend on the size of the particle. Now, I want to know how large a particle so manifesting itself will indicate that the structure is a film?

A. It is dependent on the size of the particle only insofar as the excess over and above that required to produce the film is concerned. If you have a large particle it will be necessary, in order to surround that particle with oil, to get a larger amount of oil from the film. If you have a small particle, it will take a little less oil to include that particle in an excess and

William Mason Grosvenor.

permit the particle to move down out of direct contact with the bubble.

X-Q. 62. Just what do you mean by the particles move out of direct contact with the bubble?

A. The bubble, as I have tried to define it is constituted—and as the other experts have defined it—is constituted of air surrounded by certain films which constitute a part of the bubble. If you get enough material, oil, about that bubble, the oil assumes a thickness sufficiently great to behave like oil in mass. If that particle is extremely large as compared with the particles used in ore flotation, it will take more of that excess to make the difference evident to the eye. Is that clear?

X-Q. 63. Makes what difference evident to the eye?

A. The difference between oil in bulk and oil in film.

X-Q. 64. Well, can you state this in some kind of measurements? I must say that I haven't got the point where one leaves off and the other begins yet.

A. Measurements of the particle or the film?

X-Q. 65. The film.

A. I don't get what film you want me to give a measurement of?

X-Q. 66. Well, if I have been able to grasp any point at all so far it is that when we have a certain thickness of oil surrounding the air we have a film in which, as you say, the oil functions somehow other

than oil in mass; but when we have more of a film there and more oil it functions as you state as oil in mass?

A. In the film, you mean?

X-Q. 67. What you mean is what I am trying to find out?

A. Read the question.

X-Q. 68. (Question read as follows: "Well, if I have been able to grasp any point at all so far it is that when we have a certain thickness of oil surrounding the air we have a film in which, as you say, the oil functions somehow other than oil in mass; but when we have more of a film there and more oil it functions, as you state, as oil in mass?")

A. The functioning that I have in mind is the observable functioning depending on the size of the particle, the condition of strain to which it is subjected and as I say that varies with the size of the particle, the condition of straining, character of the oil.

X-Q. 69. What is this condition of strain?

A. In the case of a free moving bubble that I have photographed it is the inertia of the mineral particle being seized and carried to the surface by the bubble. In agitation it is the whipping and turning and movement of the liquid, and, again, the inertia of the mineral particle straining at the moving bubble.

X-Q. 70. And now, suppose this straining does not result in separating the particle from the film or layer, whatever it may be, you would say that there was direct attachment or wasn't to the air bubble?

William Mason Grosvenor.

A. For the purpose in hand I should say that it was direct attachment, just as Prof. Bancroft spoke of the layer of oil when he was speaking of something more than a minute film, spoke of a layer of oil as tending to distribute itself evenly over the entire inside surface of the bubble; and then he said, "Under the force of gravity it certainly would not." Now, under other forces it would do so even less, and it is perfectly clear, it seems to me, that if you apply a greater force you can draw that film more and more to one side. If you have one oil you can drag that out to one side more readily than you can with another oil; and the net result as to whether you have direct or indirect attachment is the subject of final proof of whether it is attached or not.

X-Q. 71. That is final proof whether it is detached or not?

A. I think so.

X-Q. 72. Well suppose we assume that the conditions are those prevailing in the practice of this flotation concentration process. Now, as long as the mineral particles are not detached from bubbles, and are recovered in froth, you say it is direct attachment?

A. There are factors in what you have called "the commercial practice" that, frankly, I am not competent to speak of. I can speak of what I have seen, have tested, and know, but I do not pretend to be an authority on commercial flotation.

X-Q. 73. Then your testimony is not going to help

the court to decide whether, if the particles remain attached to the bubble sufficiently to be recovered in the froth, they are what you call "directly attached" or not?

A. That is a matter which the court must decide. I hoped it might.

X-Q. 74. You have no opinion or idea on the subject?

A. On that subject? I think it may.

X-Q. 75. Defining this direct attachment?

A. I don't quite get the question definitely.

X-Q. 76. I will restate it. You have referred to the direct attachment, which I cannot define for you, because I don't understand it. You have referred to an indirect attachment in which the particle pulls out the oil, you say, and becomes detached. Now, we have these two things, whatever they are. Now, in the practice of this flotation froth process or the pneumatic froth process, my question is if the air bubbles come to the surface and float and the mineral particles remain in them, and are recovered in these bubbles floating off from the froth, is that an indication that they were directly attached or that they were indirectly attached or that they were attached at all?

A. It would seem to me if they remained in the bubbles and are attached to the bubble, they are attached.

X-Q. 77. Directly, as you define it?

A. I think so.

William Mason Grosvenor.

X-Q. 78. Regardless of the quantity of oil used?

A. If they remain in the bubbles, yes.

X-Q. 79. Well, the term "critical point" as created in this controversy, now where does that come in? The point where these particles fall off instead of remaining attached to the bubble?

A. The term "critical point" may scientifically be used for any change, any maximum or any minimum. Now, I want to know what critical point you refer to because I can't pretend to—

X-Q. 80. Well, a layman's definition of a critical point as given in the ordinary dictionary made for the common people is that it is a point at which transition takes place, a transition point, as far as I am able to grasp it. Is that correct?

A. That would be a perfectly correct definition.

X-Q. 81. How do you define it otherwise?

A. I have not attempted to define a critical point in any such connection as this. What I am trying to get at is, when you ask me about the critical point connected with the question, I want to know what you mean by that critical point. What is the meaning of it?

X-Q. 82. In this particular case?

A. Yes.

X-Q. 83. Well, I mean that point at which the direct connection ceases and becomes displaced by the indirect connection?

A. I should regard that as a very critical point.

X-Q. 84. And what is that as regards the amount of oil used?

William Mason Grosvenor.

A. Depending on the size of the mineral particle, (and I believe its character, although I am not quite clear about that yet) also certainly its shape and size and the character of agitation. All of these factors enter in to determine whether, as a practical proposition, something can hold on to something else.

X-Q. 85. Well, then, any given body of pulp containing ore ground, as it always is, to any considerable degree of fineness from the coarsest down to the finest, that is in it we have several million different critical points, one for each different sized particle there?

A. If the particles were acting alone, yes. If they are acting altogether you get a co-operative minimum, an average of what really works and doesn't work.

X-Q. 86. Simply have a composite?

A. Practically so, because the particles help to hold one another more or less. And you get what might be called an actuarial average. In other words you get a result.

Q. 87. Can't you give us that? If there is such an actuarial result, what is the point?

A. Not without a precise knowledge of all the conditions, and I frankly admit that I have studied the smaller particles, the particles by themselves, to ascertain the laws that might apply, and that, in my opinion, do unquestionably apply, rather than the actuarial averages of the commercial flotation process.

X-Q. 88. Well, now, do you understand that the direct connection, as you have called it, between the particles of mineral and the bubbles is the characteris-

William Mason Grosvenor.

tic of the process described in the patent here in suit?

A. I am not an authority on the patent here in suit.

X-Q. 89. I am not asking you about it as a patent. I am asking you about it as a description of the process.

A. With regard to the process, if you mean a commercial process, why again, I am not, I think, qualified to speak. But, if what you mean is do I regard the question of whether it attaches or does not attach as being characteristic of what seemed to me the characterictic phenomena of this process as exemplified, I should say that it was quite clear in my mind that the specific example had direct attachment. There is nothing tangible or visible in the ordinary sense between the mineral and the air; certainly nothing between the mineral and the bubble.

X-Q. 90. By "the specific example" you mean the instance given of the quantities and of the kind of ore that appears on the first page of the patent in suit?

A. Not altogether. I do not mean to confine myself to one example rather than another. In fact I am not sure—I simply would not confine myself to that, but that would be included.

X-Q. 91. Well, what other thing would you include that is in the patent, the reference to using less than one per cent of oil? Do you refer generally to using two one-hundredths or five-tenths per cent?

A. No. When I take an ore, whether it is the

ore mentioned in the patent in suit, which I have not had any large quantities of, and apply to these mineral particles a bubble of air, I find a certain condition attained. When I apply to that mineral an amount of oil which is calculated from the proportions of oil there given and the amounts of mineral in the ore, I find a certain definite characteristic kind of attachment of these particles to these bubbles which to my mind is characteristic of that process in the sense of scientific characterization. Now, to what extent that may be masked or overcome or overloaded with useless other material and still get away with the process commercially I am not competent to say.

X-Q. 92. What are these observations you make upon this ore that is mentioned in the patent? How did you proceed? That is what I want to know, to find out what the process is.

A. By mixing the material as thoroughly as possible.

X-Q. 93. Grinding it up first?

A. Grinding it up, yes.

X-Q. 94. How fine did you grind it?

A. The samples which I have had furnished me of the Broken Hill—I have not been to Broken Hill and have not myself obtained the ore—were ground. To this oil was mixed with a certain percentage specified in the specific example I believe, but as given to me, my recollection is 0.2 per cent or 0.1 per cent —the precise quantity was, so far as I was concerned, not limited—a minute quantity—and this is mixed

William Mason Grosvenor.

with the ore, and the two are thoroughly mixed either by violent agitation in the pulp or dry mixing together, and then the condition of these particles is examined, they will be found to take hold of, or be taken hold of by the air bubbles in the way that has been described as direct attachment.

X-Q. 95. May I interrupt you? Just how did you make that agitation? You say that you have agitated this mixture and that the bubbles must have risen to the top or be rising. Did you make an observation to see whether the attachment was of one character ~~of~~ or another? How did you do that?

A. Did it in one of two ways, either to examine the film of the bubble as it stood with a glass or to examine the film of the bubble under the liquid with a glass. The other way is to remove the particle from the froth which is formed and examine the position of these particles in the bubble films, where they go. Just as Prof. Taggart described in the examination of his films, and he found that in the film—

X-Q. 96. That is what you found then?

A. That is what I found, that quantity of oil is minute enough and, in the illustration that we are discussing, it was practically impossible to see the inside film, but I have every reason to believe that it was there.

X-Q. 97. I suppose now you have examined these bubbles and froths made with larger quantities of oil and observed a different condition, have you?

A. The much larger quantities of oil unquestionably produce an entirely different condition.

X-Q. 98. Well, how much larger?

A. In the experiment that I have tried under the conditions that I have been working, twenty-five per cent perhaps on the weight of the total material would produce a condition that was to me radically different from the other.

X-Q. 99. Twenty-five per cent?

A. Twenty-five per cent.

X-Q. 100. On the weight of the ore or the mineral?

A. On the weight of the ore, but presumably a large majority of the oil went to the mineral—I am not prepared to say just how much there was in the mineral.

X-Q. 101. How would you characterize the float which you obtained with that twenty-five per cent of oil?

A. That would depend I think upon the conditions, many of the conditions which were used in obtaining the float. The floats that I have obtained with that quantity of oil were distinctly oil floats under the conditions that I was working.

X-Q. 102. And where was the mineral found in that float?

A. The mineral was found in that float included in masses or globules of oil which were, so far as I can judge, separated from the air masses by films of water, but certainly there was no tendency of the

William Mason Grosvenor.

mineral to pull itself to the edge of the air. Just exactly as we saw yesterday the mineral, when covered in oil, does not seem to have any attachment for the air-oil interface.

X-Q. 103. Well, now we will assume that we have concentrated an ore by the method of adding oil to the pulp and agitating it and producing a froth and in that operation we have used say sixteen per cent of oil relative to the weight of the ore and we will assume further that we have made a highly satisfactory recovery as to the grade of concentrate. Now, under these conditions you will grant that the mineral is floated. Now, what I want to know is whether that attachment of that mineral is direct or indirect, for that quantity of oil, and if there is any medium place in between? Did it have any element of directness in its attachment to the air.

MR. WILLIAMS: I would like that question read.

X-Q. 104. (Question read.)

A. By "attachment to the air" you mean attachment to the bubbles in the sense that I have been using it?

X-Q. 105. Yes, to the bubbles?

A. I would say first that I can only determine that by examining the material as I find it. I cannot decide from any hypothetical set of conditions which I have not carried out in the first place, and all of which are not specified in the second place, what I would get.

William Mason Grosvenor.

X-Q. 106. Then, under the condition of my question, it is purely a matter of scientific investigation to determine these things?

A. It is a question of fact what happens.

X-Q. 107. Yes, scientific fact. The directness or indirectness of attachment of the particles to the bubbles cannot be determined at all by the fact that the mineral is floated and recovered and sold at a profit? That has nothing to do with this distinction, has it?

A. I can conceive of mineral being recovered, floated—if by "floated" as I understand in your question you simply mean carried in some way to the surface without its being an air froth flotation. I may have missed a portion of your question, but I don't recollect that that was so defined.

X-Q. 108. So I take it that on any given operation of concentration at any mill, nobody but a man of scientific attainments and with scientific apparatus and equipment and after a scientific examination and careful testing would be able to tell whether this mineral was or was not directly attached to the bubbles?

A. You are asking me about the characterization with which I am familiar, and in which I am competent. What another man could do is not for me to say, but I suspect that the treasurer might be able to tell.

X-Q. 109. What?

William Mason Grosvenor.

A. The treasurer might be able to tell.

X-Q. 110. You mean the treasurer of the company?

A. Yes.

X-Q. 111. Whether they make money or not?

A. Yes.

X-Q. 112. That is the test is it?

A. No. I think he might have his ways of determining just as I have mine, and as the men who are operating the cells seem to have theirs when they recognize the desirable conditions for working or the less desirable conditions for working, and go and vary it according to their own judgment. But my way of determining the thing is the way which I understood you to ask me about.

X-Q. 113. And that required painstaking and careful scientific investigation, did it not?

A. That is what I am ready to do.

X-Q. 114. They do require it, do they?

A. My ways do, yes.

X-Q. 115. And you do not know of any other way, do you?

A. I know of many other ways in which I am not skilled, as I say. I know that the men at the cell can tell immediately whether the conditions are desirable.

X-Q. 116. From what viewpoint?

A. From their viewpoint.

X-Q. 117. Is that the viewpoint of finding out whether they recover the mineral or finding out

whether there is some kind of a particular attachment between the mineral particles and the bubbles?

A. I presume purely from the question of recovering the mineral, and in a few cases all I want to know is whether the mineral sticks to the bubble?

X-Q. 118. Well, now, do you believe there is a critical point between this direct attachment and this —whatever you call it—indirect attachment of the mineral to the bubbles? Is this something that changes like a snap of the fingers at a certain point, or is it something that melts away gradually like the difference in the colors from one end of the spectrum to the other?

A. Under any precisely fixed set of conditions, if you can assume such a fixed set of conditions, I think that the limit comes with reasonable sharpness. And by that I mean a relatively small difference in the amount of excess oil.

X-Q. 119. Well, a difference of what magnitude?

A. Ten or fifteen per cent of the amount of oil present, perhaps. Something in that order.

X-Q. 120. That is for instance if one per cent gave you direct attachment, your estimate is that 1.15 per cent would be a suitable increase to go beyond this critical point?

A. As I have measured the thing with all the conditions fixed, as carefully and accurately as I could determine them from changing the rate of movement of the bubbles, from changing the size or the shape of the bubbles, you get an entirely dif-

William Mason Grosvenor.

ferent state of things, and no such approximation I think could be made for widely varying conditions such as would be found in the agitation cells that I have used for experimental work. You have almost an actuarial average there.

X-Q. 121. Well, assuming constant conditions, and assuming that we get a very satisfactory result with one-tenth of a per cent of oil relative to the weight of the ore, now we will say farther that we increase that amount by fifteen per cent, which would give us, if my arithmetic is right .115 per cent of oil. Now, this condition being constant, and we getting a good result with one-tenth of a per cent of oil, when we increase that to .115 per cent we are, in your opinion, beyond this critical point, and operating without the direct attachment which you have defined?

A. Now, let me make sure that I understand you. You are speaking now of a definite critical point as I understand it. You are speaking of a point which is the amount with which you get your best results. Or are you talking of the maximum amount with which you can load the process without totally defeating it?

X-Q. 122. I am not talking about either of them.

A. Then I don't understand.

X-Q. 123. I am talking about why you haven't answered my question. I asked you what the critical point was and you said it was reasonably definite. And I said "How definite?" And you said it would

be accurate within a range of fifteen per cent of the amount of oil you were using. Now, I assumed that we were getting a good result with one-tenth of a per cent of oil.

A. What is a good result?

X-Q. 124. I do not say the best result; we are getting a direct attachment. Now, I don't understand that there are any different kinds of direct attachment. It is the direct attachment with the one-tenth of a per cent of oil. Now, I raise the amount of oil by the amounts which you said will cover this, as I understand. Now, my question is have you destroyed the direct attachment, as your testimony indicates it would, and, as to operation, would some of this oil neck, or stretch out (oil films) that you have been telling about, which are not the direct attachment?

A. If you had your mineral just on the surface of the bubble, as I have had it when I have been working with them, and if conceivably you had an oil so light that such a small fraction could not merely coat the bubble, but coat the mineral particle to the point at which it separated from the bubble surface, and if then you assumed that to be, you had that maximum amount which will hold it, you then add ten per cent, my experience is that you let that particular particle go from that particular bubble.

X-Q. 125. You do what?

A. That you let that particular particle go from

William Mason Grosvenor.

that particular bubble which supports it. Does that answer the question?

X-Q. 126. Aren't you getting a little afield? I thought my question was pretty definite?

A. I think not.

X-Q. 127. We assumed the conditions were constant except that of oil, .115 per cent of oil. Now, the question is have you destroyed the direct attachment and is the particle wobbling around at the end of a dangling neck of oil and therefore outside of this point? That is definite. That ought to be susceptible of an answer?

A. It is, provided you make plain or answer my question as to what you meant by "critical." You have been speaking of a critical point to get a good result in the case. Might I carry the implication that this is all that you can use to get the best results, or is this the least you can use to get the best results?

X-Q. 128. One-tenth of a per cent, you mean?

A. The one-tenth of a per cent.

X-Q. 129. Are there several kinds of direct attachment, best direct attachment and so forth? I understood that that was a definite thing and one-tenth of a per cent gives it to you.

A. It is just as definite as the fact that I can nail a board to the floor with forty nails or with one nail. Now, you can have direct attachment with anything less than the amount of oil which will defeat direct attachment.

William Mason Grosvenor.

X-Q. 130. I think I get your idea, doctor. Now, we will assume this, that we get the direct attachment with one-tenth of one per cent of oil and that that is the maximum amount, according to your ideas, that will give the direct attachment. Now, I give you that, I have answered your question because of course if you add anything to that you wouldn't have it?

A. Exactly.

X-Q. 131. How wide a range is there over which you can get this direct attachment—how wide a range in quantity of oil; do you know any concrete instance of that?

A. You mean from the maximum that will produce direct attachment to the minimum that will produce direct attachment?

X-Q. 132. Yes.

A. The minimum that will produce direct attachment, as has been stated, is nothing at all, because you can get a perfectly satisfactory direct attachment without the use of any oil. The maximum, as I said, is something which I can not specify without accurately given physical conditions. In the cases that I have observed of the captive bubble, (which is the only one actually where you can make accurate measurements—and that was the reason for selecting it) ~~in~~ the amount of oil there, even, depends on the character of the oil (and to some extent on the presentation of the bubbles to the oil; but the presentation of the bubble has very much less effect) within ranges that

William Mason Grosvenor.

seem to me to be about ten or fifteen per cent. The amount of oil in a given case is about the same.

X-Q. 133. You showed us the attraction of an air bubble for mineralized particles in water yesterday, didn't you?

A. Yes.

X-Q. 134. Then you oiled the particle?

A. Yes.

X-Q. 135. And after you removed as much oil as you could with the air bubbles, there did not seem to be as much attraction as there was without any oil; did not that seem to be the case?

A. After having removed as much oil—

MR. WILLIAMS: Read the question.

X-Q. 136. (Question read as follows: "And after you removed as much oil as you could with the air bubbles, there did not seem to be as much attraction as there was without any oil; did not that seem to be the case?")

A. By "attraction" you mean the strength of attachment?

X-Q. 137. The force that held them together.

A. I think slightly less; all the testimony shows that.

X-Q. 138. That the presence of oil decreases the strength of attachment?

A. Yes.

X-Q. 139. Now, when you told me that a decrease of 15% in the amount of oil being used would

be sufficient to cover the critical change and effect the transition from a direct attachment to an indirect attachment, what are you figuring the 15% on, the minimum amount or the maximum amount that would cause direct attachment?

A. I have stated, the maximum.

X-Q. 140. Now, what is the maximum in any given case; can't you measure it in terms of thickness of the film or weight of the oil, or is there no way on earth to tell what it is, other than to characterize it as a maximum?

A. As I said, there is no broad maximum. That is easy to understand. The size of the particles, the relative size of the particles, the character of the mineral and the shape of the mineral all make a difference in what amount of oil will be required as a maximum; but the general range of that maximum, and in many specific cases as I have carried it out that maximum is in the vicinity of three or four per cent up to six or eight per cent of the actual weight of the metallic particle. Those determinations were made with bubbles, which raised particles of selected size and weight, and as I say, the difference in the size of the particle will make a difference in that point; but there seems to be in every case this limit, beyond which we can not go without destroying the strength of the attachment. Now, in a general way that limit comes in that general vicinity. If we take a particle which is the maximum that a bubble will

William Mason Grosvenor.

carry—I mean the maximum that the attachment of the bubble will sustain, and you get right up to the limit, so that it is attached but you don't know whether it will stay on there at all—a condition which may be compared to the flotation of metallic platinum—where the strain on the bubble is extremely heavy, then the limit of oiling or impurity on the surface is very quickly reached.

X-Q. 141. Now, I say you have told me that when you claimed that 15%, you meant to base it upon the maximum amount that would produce the direct attachment of the particle to the bubble?

A. Yes.

X-Q. 142. Now, if we state the maximum amount that will produce it, doesn't that mean that an infinitely small amount above that will destroy it; if it is the maximum, why do you have the 15%?

A. Because I speak of determinations I made and measurements which I have carried out, and in that class of experiment, no man, when he speaks of a maximum amount, undertakes to carry it out to a fraction of a per cent. We are dealing with measurements, and I speak, not of the fact that 15% more would do it, but that 15% was about the range of my determinations. I don't know whether it is a fact that under one set of circumstances, a change in the temperature or something else, 15% more is permissible. But of course, mathematically what you say is perfectly correct.

X-Q. 143. Then you did not mean the maximum at all, but you meant that your determinations had in them an element of error equal to 15%, and so that to allow for that element of error you would have to add 15%, not because the critical point in that amount was indefinite, but because there was an area of error that had to be covered?

A. I think it may be either a variation in the accuracy of the determination or a variation in the conditions. We speak of the tensile strength of steel, and that varies with the rate at which the load is applied, and varies with a number of conditions which are too minute in many cases to be sure just what they are; so we speak of the maximum tensile strength, and I was speaking of it in the practical common sense way, rather than in a mathematical way.

X-Q. 144. Now, I wanted to know about the particles as to how much oil would destroy the direct connection, and I find you said about 3% of the weight of the particle. What sized particles are those that you experimented with?

A. I don't think I said 3%; my recollection is that I said from four to eight per cent, depending on the conditions.

X-Q. 145. Well, four to eight per cent. I did not intend to misstate it. What was the size of the particles upon which you made that determination?

A. Those determinations covered by that range have been repeatedly carried out with galena particles

William Mason Grosvenor.

weighing from four to six milligrams, selected to be as near cubical as possible, and on aluminum discs, which I stated yesterday were 5/32nds in diameter, punched out, and having a weight of from 27 or 28 up to 35 or 40 milligrams. As compared with the maximum lifting power, I think perhaps it would be well to know what standard of comparison they are, because their relation depends on whether the bubble is correct in size, because if you have an abnormal relation between the bubble and the particle, you can vary almost any measurement; just as the contact angle almost disappears when the bubble is under strain if the bubble is too small; but the maximum was about 40 milligrams of galena and about 104 miligrams of aluminum disc. Now, it makes a great difference what oil you use, too.

X-Q. 146. Will you tell the court how many million times as heavy these things you experimented with are, than an average sized particle which is concentrated by flotation; I can give you the screen analysis of the Butte & Superior, if you want it, to make it definite.

A. I don't think that is necessary. I think the question can be answered in a very general way, that the weight of those particles is proportionately greater as the violence of the movement is proportionately less; that there is no necessary connection between the weight—

X-Q. 147. I wish you would answer the question

and explain afterwards; I want to know how many million times greater these particles you experiment with are than the particles met in ore flotation.

A. I haven't calculated it.

X-Q. 148. Can you do so?

A. I think so.

X-Q. 149. They are several million times as great, aren't they, according to your ability to size up the situation without calculation?

A. I don't know as it would run into millons, but it is a pretty large figure, yes.

X-Q. 150. As I understand what you have said. the quantity of oil which will result in this direct connection can not be determined by any relation to the weight of the ore itself?

A. I made no such statement.

X-Q. 151. What would you determine it by? If it is determined by the relation to the weight of the ore I want to know it?

A. The only way I know of to determine it would be to try it and see whether it produces direct attachment or not.

X-Q. 152. That is the only way you can find out? You can't tell by the thickness of the film?

A. With any particular oil or with any particular ore, I think that would be the only final way of doing it. You have certain past experience that would lead you to expect certain results, but the only way to be sure would be to do it.

William Mason Grosvenor.

X-Q. 153. I want to read something that you testified to yesterday, and ask a question: "By attachment, either indirect or direct, and possibly very intimate, between the ~~oil~~ air and the mineral, I do not limit the kind of attachment to surface tension or electrostatics, or any other cause or method of attachment; but when I speak of direct attachment I mean the direct attachment of that mineral particle to the air bubble, which is intimate and physically immediate, holding the two together as a whole, with whatever adsorption layers there may be on the surface either of that mineral particle or of the bubble as a whole. Where something comes between the mineral and the air, with ~~ore to~~ a practical, substantial, effective action to ~~extent which~~ separate~~s~~ them in space and materially affects their inter-action ~~connection~~— For the purposes in mind, I would call the attachment then an indirect attachment." Page 2137. (Q9) Now, that last sentence seems to hinge this indirect attachment on something interfering between the inter-action of the air with the mineral. Now, I don't understand what you mean by that; do you mean that the air exercises an attraction for the mineral as a magnet does for a piece of iron?

A. Before going into the answer—I haven't seen the record—There is period before "where" is there not?

X-Q. 154. Yes. Do you want to look at it?

A. As I stated yesterday, there are two possibilities, both of which are recognized in the testi

mony of the experts for the defense. One is that the mineral is attracted by air (in the broad general way that metal is attracted by a maget—by some force). The other is that there is an action of the bubble films (as, let us say, stretched membranes, to abbreviate). I think that both of those are capable of producing direct attachment. To what extent one or the other is effective I think depends entirely on the conditions.

X-Q. 155. When you pick up a bubble in the bubble holder in pure water, as you did yesterday, what is your opinion as to the force that holds the particle to the bubble?

A. You are now speaking of pure water and a clean particle?

X-Q. 156. Yes.

A. I think that the attraction of the air for the mineral particle at the surface of the mineral particle prevents the getting in of water over that surface of the mineral (and you might call it adsorption of that air layer if you like to step behind another veil), but it is simply and finally the non-wetting character of the mineral, caused, in my opinion, by the air, which forms at the outside of that area of non-wetting a wall against the water, and that that wall of air on the inside of the water on the outside, has what we call a surface tension, and that that lifts the particle.

X-Q. 157 That the actual mechanical lifting is done by this surface tension?

William Mason Grosvenor.

A. As far as I know, yes.

X-Q. 158. And not by the air itself, except insofar as the presence of the air gives rise to this surface tension?

A. Insofar as the air is directly attached to the metal, and will not permit the water to come over, that is all.

X-Q. 159. But you don't mean that there is any tension through the air, that the particle hangs on air, or anything like that?

A. Why, air alone is as bad as the oil neck; it is very much worse; it has no cohesion whatsoever. You could not make a string of air and hang a particle on it.

X-Q. 160. Well, haven't you in your testimony referred to the attraction of air for a mineral particle as extending through films of a certain thickness, on which you get the maximum—"molecular action," I think you referred to it as?

A. Yes, and in that testimony I was speaking of precisely the same phenomena—perhaps in less scientific words—that Professor Beach and Professor Taggart, as I recollect, both referred to—both spoke of there being a commingling, and what they were talking about as an adsorption layer, between the air and the oil, and the layer between the oil and the mineral. As I understand it, if there is an adsorption layer of air and mineral, it holds back the water. It is the attachment of the air to the mineral which really, followed back as far as you can go, does the work. In this case,

if the air gets through a minute film of oil, and is still effective to hold back that water wall, I would call the element of that attraction a part of the lifting force.

X-Q. 161. Really in the same sense that you apply it to the bubble holder?

A. Substantially so; not as a string.

X-Q. 162. In your diagram No. 1 which you submitted yesterday, as I remember it, you showed the outline of the bubble which presumably is the wall of the bubble—whatever it may be scientifically—as bulging at one point, and the particle lying inside of that wall at that point. Now, if that is the correct representation of the particle, that is oil within the wall of the bubble, how was it that, when you lifted the bubble holder out of the pure water yesterday with a bubble on it, you found the particle covered with quite an appreciable amount of water, or at least if not covered, carrying it in spots?

A. I did not find the particle carrying any.

X-Q. 163. My recollection was that you found it wet after you took it out. I may be mistaken.

A. I don't know what surface that was, and if the diagram indicates—the diagram appears to be missing.

MR. WILLIAMS: It was sent to the printer to be copied and has not been returned yet.

THE WITNESS: There was no intention to imply by that diagram that there was or was not any contact between the water wall and the under side of the mineral particle.

William Mason Grosvenor.

X-Q. 164. I think the diagram was a little ambiguous in that respect. We will take that up later when the diagram is here.

A. There is no question but what there are portions of the under face of the particle that are wetted. Examinations with the microscope at different temperatures leads me to believe that that is not a continuous wetting by any means. How far that was effected one way or the other, I don't know, but broadly speaking I should say that the under side of that particle was at least partly wet.

X-Q. 165. Here is a passage that I don't quite understand. I would like you to explain; page 2140: "In my opinion it is quite possible that there should be such attachment directly through an oil layer if the oil layer is sufficiently thin, though it is obviously not necessary or essential to the success of the air froth process as far as we can see today." Do you mean by that that it is direct connection of the mineral particle to the bubble, that that connection is not, as you say, essential to the success of the air froth process; that is, does the air froth process include something else, and if so, what?

A. No; I meant that the intermingling of the air and oil at the inner face of the oil layer or film—film is better here because we are dealing with an extremely thin layer—intermingling at the inner face of the oil film, of the air and oil, and the intermingling at the outer face, of the mineral and oil, may have no effect. The correctness or otherwise of that theory—the correctness or

otherwise of my belief that there is an action through a sufficiently minute oil film on the air on the inside, is not in my conception at all necessary to direct connection, and therefore not necessary to air ~~oil~~ flotation; that is simply one of the ways in which it may be effected.

X-Q. 166. Now, I think that this direct action which is referred to here is the action of the air inside of the bubble extending through the distance that this molecular action does extend, and assisting in some way in drawing the particle into the wall of the bubble, is that right?

A. To put it the other way, holds the water back from the face of the particle.

X-Q. 167. Holding the water back, yes. Now, if that element is not present, you can still have what you call direct connection?

A. Something else may prevent the water wall from coming in, or the liquid wall, perhaps I should say.

X-Q. 168. What else, doctor?

A. Precisely the same forces which are recognized when we speak of an extremely minute adsorption layer of oil on the inside of the bubble, inclosing the mineral particles. There are many forces that work there, and I do not mean to exclude the forces either, which Prof. Beach and Prof. Taggart have included there, but to point out, as I said, that it is not material, except as to illustrating the relative thickness of the layer. There is no difference of opinion between us there that I think is serious.

William Mason Grosvenor.

X-Q. 169. Now, you would include in this direct attachment the drawing in of the mineral particle into the bubble film by adsorption, regardless of whether it was beyond the direct molecular action of the air inside the bubble or not?

A. Direct contact?

X-Q. 170. (Question read as follows: "Now, you would include in this direct attachment the drawing in of the mineral particle into the bubble film by adsorption, regardless of whether it was beyond the direct molecular action of the air inside the bubble or not?")

A. Yes, provided the film were a film and not a mass of oil. I would not include as direct attachment the mere taking in that has been called adsorption; (I think it is a loose use of the word)—the mere adsorption of the mineral particle into an oil-water interface which was remotely connected somewhere with a bubble of air.

X-Q. 171. But the force of adsorption would be just the same, wouldn't it, regardless of whether you had a layer an inch thick or one very thin?

A. That was precisely the point that I brought out, that I don't think the connecting phenomenon is the adsorption phenomenon at all, because the adsorption is equally capable of moving the mineral particle into a ton of Elmore oil, or into the vanishing, almost infinitismal quantity of the air froth layer or film of oil.

X-Q. 172. Then the direct attachment we were talking about in these last few questions and answers, it is

not dependent upon this direct molecular action of the air within the bubble, as you term it, I think—it is not necessarily or essentially connected with the drawing in of the particle to the film by adsorption, but the direct attachment is wholly a matter of the thickness of the oil layer upon the bubble, because those are the only three things there are?

A. For any given set of conditions, oil, mineral, bubble, etc., yes; that is purely a question of the thickness of that layer at any given set of conditions.

X-Q. 173. Now, your position, as I understand it is, that when that layer is very thin, we have what you call direct attachment, and that direct attachment is a firm attachment—that when that layer has reached some certain thickness by reason of the thickness of that body of oil, the attachment becomes weak, and the oil pulls out, and the particle gets away?

A. That is my position, as confirmed by Prof. Bancroft's statement.

X-Q. 174. Now, do you say that between this layer that holds the particle tightly to the bubble and that thickness of oil which will pull out and release the particle, that there is any critical point? Isn't that merely a question of the degree of thickness, and that the attachment according to your theory will simply become weaker and weaker and weaker, until finally it is too weak to answer the purpose?

A. Under any set of conditions—you have a fixed load on a rope, let us say. It is a matter of degree, perhaps. By and by that rope breaks; but if you draw a

William Mason Grosvenor.

knife across it and cut one bit more than a certain strand, it is good bye.

X-Q. 175. Then the critical point—it seems to me we are making progress—is the point at which the particle breaks loose; that is the point in the thickness of the layer?

A. The critical point to which I refer and which I have tested in my work, is that critical point where the attachment ceases.

THE COURT: It seems to me like the problem of "What addition will make a heap of that which was not a heap before?"

THE WITNESS: Or, "When does a pig become a hog?"

Whereupon further hearing was adjourned until 2 p. m.

2 o'clock p. m., Wednesday, May 9, 1917.

MR. WILLIAMS: At first I wish to make a request of the court. We wish to show to your honor the moving pictures, and that has to be done in the evening, and we suggest an evening session on Friday.

THE COURT: What are these moving pictures—the ones spoken of by the witness?

MR. WILLIAMS: The moving pictures prepared by Dr. Grosvenor. Mr. Scott has consented to suspend the cross-examination of Dr. Grosvenor to permit another witness to come to the stand who has illness in his family and must return.

Albert E. Wiggin.

ALBERT E. WIGGIN, a witness for plaintiff, after being duly sworn, testified as follows:

DIRECT EXAMINATION.

BY MR. KENYON:

Q. 1. Give your full name.

A. Albert Edward Wiggin.

Q. 2. Age and residence.

A. Thirty-two years old, residing in Anaconda, Montana.

Q. 3. Occupation?

A. Superintendent of concentration in the state of Montana for the Anaconda Copper Mining Company.

Q. 4. Will you give briefly a summary of your education and experience in metallurgical directions?

A. I was educated at the Massachusetts Institute of Technology graduating in 1907. From there I came to Great Falls to work for the Boston & Montana Consolidated Copper & Silver Mining Company in the testing department. After about a year spent in the testing department I was made assistant to Mr. Wheeler, the superintendent, and carried out miscellaneous tests and experimental work under his direction.

Q. 5. Is that a subsidiary of the Anaconda Copper Mining Company?

A. It is connected with the Anaconda Copper Mining Company through the Amalgamated Company. It was a subsidiary of the Amalgamated. With Mr. Wheeler I developed an improved system of water con-

Albert E. Wiggin.

centration, which was installed at Great Falls, and during December, 1911, I was sent to Anaconda to install this system in one section of the mill at Anaconda. I remained in Anaconda, and during 1913 was made concentrating engineer for the Anaconda Company. During the latter part of 1913 I had charge of the construction of a 2500 ton round table plant for the treatment of mill slimes. This plant was put in commission about the middle of March, 1914. It operated successfully until the middle of December 1915, when it was replaced by an oil flotation slime treatment plant, using the Minerals Separation Company machines. During May and June of 1914 we started test work on the flotation process for the treatment of our concentrator slime and tailings, using a Minerals Separation Company machine, and I took charge of that work. We started to remodel our concentrator in January, 191~~4~~5, taking one section at a time and installing Minerals Separation flotation process to replace the tables at the lower end of the flow sheet. The remodeling of the entire mill, consisting of eight sections, was completed about the middle of January, 1916. On the first day of May, 1915, I was made superintendent of concentration in the state of Montana, for the Anaconda Copper Mining Company.

Q. 6. Will you now in some detail set forth the character and extent of the investigations that were made under your direction of flotation concentration at the Anaconda mill?

Albert E. Wiggin.

A. Early in 1914 it was decided to investigate on a fairly large scale the treatment by flotation of Anaconda slime and mill tailing. For that purpose a standard-type Minerals Separation machine was installed at the Washoe Reduction Works during May and June, 1914. This was followed by the installation of a full-sized Callow pneumatic machine plant. In addition to the tests made in the standard-type Minerals Separation machine some tests were made using a Minerals Separation machine of the sub-aeration type.

During the series of experiments a large variety of oils were tested. Experiments were also conducted using both round-table feed and tailing to determine whether it would be better to displace the round tables by flotation for the treatment of the slime, or to supplement the round tables by flotation of the round table tailing.

A series of tests was also made on the treatment of the mill tailing by grinding followed by flotation to determine the relative merits of flotation and leaching for the treatment of this product. In addition, flotation tests were made on mixtures of oil tailing and slime.

The round-table feed referred to above is the total slime from the mill. It contains about 35 per cent collodial solids and approximately 90 to 95 per cent of the total solids will pass through 200 mesh (0.067 mm.). It assays from 2.1 to 2.7 per cent copper.

The mill tailing referred to above is the total discard from the mill exclusive of the slime. It is all finer than

Albert E. Wiggin.

2 mm. and about 90 to 95 per cent will remain on 0.25 mm. It assays about 0.60 per cent copper.

A brief summary of the flotation results follows:

Preliminary tests: A series of tests was first carried out to determine roughly the best conditions for flotation, using the standard Minerals Separation machine and treating round-table feed. The following reagents were tested, either alone or in combinations: Turpentine, crude oil, cresylic acid, stove oil, tar oil, Carolina oil of tar, argole, sludge acid, fuel oil, wood creosote, and sulphuric acid. In some of these tests sulphuric acid was used and in others it was omitted. Also, the effect of the temperature of the pulp upon the flotation results was tested by heating to various temperatures.

As these tests were merely preliminary, no record was kept of the amount of reagents used. It was conclusively proved, however, that the best combination of agents was sludge acid, wood creosote, stove oil, and sulphuric acid. Fortunately, of all the reagents tested, these happened to be the cheapest. It was also proved that the addition of sulphuric acid to the pulp was of decided advantage in the treatment of the slime. In two successive tests in which sludge acid, wood creosote and stove oil were used, the tailing assayed 1.25 per cent copper.

MR. KREMER: Will your honor permit us at this time—I note the witness is reading—would you permit us at this time to interpose an objection to this charac-

ter of testimony for the same reason as assigned in the objection to the Atwater testimony that it is incompetent, irelevant and immaterial. Your honor stated in ruling you were admitting it upon the ground that it would tend to show utility. If your honor will permit a general objection to appear on the record at this time.

THE COURT: Very well, the objection will be overruled.

MR. KREMER: Exception. All of this will go in under the same objection.

THE WITNESS: When no acid was used—in two successive tests in which sludge acid, wood creosote, and stove oil were used, the tailing assayed 1.25 per cent copper when no acid was used and 0.3 per cent copper when acid was used. Since these tests were made we have omitted the use of stove oil.

Tests with Standard Minerals Separation machine: This machine, with the accessory apparatus, was installed in a separate building, south of the round-table plant. It had 16 agitator compartments, each two feet square and 14 spitzkasten, and was of the standard Minerals Separation design. This machine is known by us as M. S. Machine No. 1. The agitators were of the standard Minerals Separation type, the impellers being 18 in. in diameter and the agitators making 265 r. p. m. This gave the impellers a peripheral speed of 1,245 feet per minute. The machine required 45 to 55 h. p., including motor and belt transmission loss, when operating under a full load of slime pulp.

Albert E. Wiggin.

The experimental work on the Minerals Separation machine was carried out by George A. Chapman, and staff, of the Minerals Separation Company.

The first products to be tested were the round-table feed and tailing.

The conclusions reached at that time on the treatment of this material were as follows:

1. The economic capacity of the M. S. No. 1 machine when treating slime as produced from the mill is from 80 to 90 tons per 24 hours.

2. The best combination of reagents for the treatment of slime seems to be sulphuric acid, kerosene, sludge acid, wood creosote and stove oil. There is some question as to the real value of the stove oil. Its principal function seems to be to make a more compact froth.

3. It would not be economical to retain the round tables.

4. It is thought that the best circuit density for the slime pulp for flotation treatment is about 12 per cent solids.

5. It is thought that about 70° F. will be found to be the most economical temperature at which to keep the pulp.

6. Acid seems to be absolutely essential to the successful treatment by flotation of our slime.

7. The addition of air in the last spitzkasten is of no advantage.

8. Any considerable increase in speed of the agitators above a peripheral speed of about 1,300 ft. per minute seems to be disadvantageous.

Albert E. Wiggin.

Treatment of mill tailing after grinding through 60 mesh.

These tests were made in the M. S. No. 1 machine. Mill tailing from sections 7 and 8 of the concentrator were elevated and then dewatered. The dewatered tailing was then crushed through 60 mesh (0.25 mm.), in either a Hardinge mill 10 by 4 ft., or a tube mill 8 by 12 ft. The grinding mills were operated in closed circuit with a Dorr classifier, the overflow of the classifier being the final product of the system and going to the flotation plant for treatment.

These tests were started immediately after putting the Hardinge mill in operation. At first no sulphuric acid was added, and the pulp was not heated. We found, however, that the use of acid in addition to that contained in the sludge was of advantage. Some very low tailings were produced during these preliminary tests, but the concentrate was very low grade. It seemed to be of decided advantage to add the oil ahead of the grinding mill, the latter apparently making an ideal agitator.

Conclusions.

1. Although not definitely demonstrated, it is thought that the economical capacity of the M. S. No. 1 machine when treating sand tailing crushed through 60 mesh is about 175 to 200 tons per 24 hr.

2. The best combination of reagents seems to be sludge acid kerosene and sulphuric acid. However, a

mixture of creosote, turpentine, and pine oil, in a non-acid circuit gave good results also. The non-acid circuit, however, seems to require more delicate adjustment and more careful attendance than the acid circuit.

3. The grinding mill makes an ideal agitator, and it is of decided advantage to add the oil ahead of the grinders.

4. The treatment of the mill sand tailing ground through 60 mesh should result in a tailing assaying not over 0.10 per cent copper and a concentrate carrying not over 30 per cent insoluble.

5. It is thought that the best density of pulp is from 25 to 30 per cent solids.

6. Heating of the pulp to about 70° F. seems to be of advantage, although there is a possibility that this heating may be dispensed with during the summer months without any injurious results.

7. Acid seems to be beneficial but it is not of as much importance as in the treatment of the slime. Treatment of mixture of round-table feed and mill tailing after grinding through 60 mesh:

These tests were made in the M. S. No. 1 machine. It was thought that it might be of advantage to mix the slime and the reground mill tailing for flotation treatment. The acid sludge kerosene, turpentine and the sulphuric acid used were added in the flotation machine. In some instances, various mixtures of coal tar (70 to 80 per cent), creosote (17.5 to 22.5 per cent), and pine oil (2.5 to 7.5 percent) were used with the sludge acid. These were added ahead of the grinding mill.

Albert E. Wiggin.

The average proportion of said tailing to slime in the mixture treated was 75.7 to 20.1, or 3.8 to 1. In practice the proportion of production of tailing to slime is about 3 to 1; thus our mixture was somewhat deficient in slime. The concentrate produced, 34.1 per cent insoluble, is of a good grade, but the tailing is high, 0.20 per cent copper. Theoretically, the tailing should have assayed about 0.15 per cent copper, assuming a 0.30 per cent copper tailing from the slime.

Although this test was not conclusive it was decided, from observation, that it is better to treat the slime and the sand tailing separately. Of course, the slime which is made in the grinding of the sand tailing is included in the sand tailing for treatment. This slime produced in grinding the tailing is much lower grade and more silicious than the original mill slime.

Tests with Callow Pneumatic Machine:

Tests made by Mr. Callow at his laboratory in Salt Lake on samples of our mill tailing ground through 40, 60 and 80 mesh, and of our slime, had given such promising results that it was decided to try out the Callow machine on a commercial scale. Accordingly, there was shipped here during September, 1914, five standard Callow cells, 2 by 8 ft., a Pachuca agitating tank and accessory apparatus, consisting of blower and sand pumps. This equipment was installed in the old 80-ton experimental leaching plant and was ready for operation the latter part of October.

In addition to the Pachuca agitator recommended by

P. 4286, L. 9, after " a " insert, " 0.10 copper tailing from the sand tailing and "

Albert E. Wiggin.

Mr. Callow, we built a set of two mechanical agitators. These agitators consisted of a tank about 10 ft. long by 2½ ft. wide and 2½ ft. deep, in which revolved a horizontal shaft carrying a set of paddles. These agitators were belt driven from one motor and required a total of 25 to 30 hp., including motor, belt, and countershaft power loss. The agitators seemed to work well and had a combined capacity of about 60 tons of slime per 24 hr.

Treatment of Round Table Feed and Tailing—

Conclusions.

1. On our slime, air agitation is not as satisfactory as mechanical.

2. The capacity of one standard Callow cell is about 15 to 20 tons of slime per day.

3. The Callow machine produces a clean concentrate but does not give as clean a tailing as the Minerals Separation machine.

4. The Callow machine is more sensitive and requires closer attention than the Minerals Separation machine.

5. The cost of repairs would probably be less on the Callow machine than on the Minerals Separation machine. This cost, however, is comparatively small for either machine.

6. The power required per ton treated in the Callow system is just about the same as that required in the Minerals Separation machine.

Albert E. Wiggin.

In all of these tests the original feed was divided among the Callow rougher cells, operating in parallel. As a rule, there was one cleaner cell operating also. When this was operating the concentrate from the rougher cells went to it, the cleaner making a final concentrate and a middling which was returned to the system. The rougher cells made the final tailing.

Treatment of mill tailing after grinding through 60 mesh:

During the first few shifts the mechanical agitators at the Callow plant were used but it was soon found that they were not required—that the grinding mill gave sufficient and thorough agitation.

Conclusions:

1. The capacity of the standard Callow cell when treating ground mill tailing is about 75 tons per day.

2. No other agitation is required if the reagents can be added ahead of the grinding mill.

3. The use of acid seems to be of considerable advantage.

4. On account of utilizing the grinding mill as an agitator the Callow machine requires less power than the Minerals Separation machine.

5. The Callow machine is more sensitive and requires more attention than the Minerals Separation machine.

It was decided on the whole that the standard M. S. machine gave the better results.

Albert E. Wiggin.

It was decided to remodel the plant for flotation and to scrap the round table plant.

Q. 7. Will you now give a description of the remodeled concentrator plant that was installed after that decision?

A. I have here a flow sheet of the remodeled mill and also of the slime flotation plant, which will supplement my verbal description.

The ore from Butte is receievd in 50-ton dump cars, and dumped into the concentrator bins. The concentrator consists of eight 2000-ton sections. The ore is first crushed through 2 inches, then screened over one inch, and the one inch to two inch product is treated by jigs. These jigs make a concentrate and a middling. The middling is further crushed and returned to the system. The minus one inch product is screened on ⅜ of an inch, and the oversize treated on another set of jigs, making a concentrate and a middling. The middling is further crushed in rolls and returned to the system. The concentrate from these two jigs is finished concentrate and goes to the smelter. The undersize of three-eighths passes over a 5 millimeter or 7 millimeter screen, and the oversize of that passes through a set of Evans jigs, which make a concentrate and a middling, the concentrate going to the smelter and the middling being crushed in the finishing rolls, through one and a half millimeter. The undersize of the 7 millimeter screen passes in 1½ millimeter screens and the oversize is treated by Evans jigs, making a concentrate and a middling, the mid-

Albert E. Wiggin.

dling being further ground in the finishing rolls mentioned above, through 1½ millimeters, and the concentrate going to the smelter for treatment. The total undersize of the 1½ millimeter screen passes through Anaconda classifiers, which overflow the slime material approximately passing 8/100 of a millimeter. This slime goes direct to the Dorr thickening plant, where it is thickened to approximately 15% solids, and is then sent to the slime flotation plant. The overflow from this Dorr thickening plant is practically clear water. The spigot discharge from the Anaconda classifiers, carrying material finer than 1½ millimeters, with the bulk of the slime removed, passes over Wilfley tables, where a concentrate is taken out and sent to the smelter and a middling is produced which goes to the grinding mills. These grinding mills consist of 7½ ft. diameter by 6 foot cylinder Hardinge ball mills in all sections except one in which there are 8x12 pebble tube mills. The crushed product from these mills goes to a Dorr classifier, from which the coarse sand is returned to the mill. The overflow from the Dorr classifier is approximately minus .25 millimeters, and passes to flotation. This product is fed by elevator into three standard flotation machines. The oil and acid are added ahead of the elevator which feeds these machines. The oil used is kerosene sludge acid, and sometimes we use wood creosote from the Cleveland Cliff Company, which is a hardwood creosote, and sometimes we omit the use of this; we use sulphuric acid.

Albert E. Wiggin.

Q. 8. Give the quantities of oil and acid.

A. We use about three to three and a half pounds of sludge acid, and from six to eight pounds of 60° Be. sulphuric acid.

Q. 9. Per ton of ore fed?

A. Per ton of ore fed to flotation. The Minerals Separation machines make a clean concentrate from the first seven spitzkasten, and a middling from the last seven, which is returned to the feed to the machines. A portion of the pulp is overflowed from the last three spitzkastens, together with the froth. I might say that these Minerals Separation machines are standard type machines, having three foot square agitating compartments, and the usual form of spitzkasten. The agitators make 225 r.p.m., which gives a peripheral speed of about 1410 feet. They are driven by 150 h.p. motors, actually using about 90 h.p. The spigot product from the last spitzkasten is the final tailing, which is sent to the dump. The concentrate from the first seven spitzkasten is finished and goes to Dorr thickening tanks and then to Oliver filters and to the smelter. This completes the treatment of the spigot product from the Anaconda classifiers.

The slime which overflows from these classifiers is, as I said, thickened and passes to the slime flotation plant. This plant consists of 20 standard type Minerals Separation machines of the same design as those used in the main mill. The first nine spitzkasten of these machines make a finished concentrate which is de-watered in Dorr tanks, followed by Oliver filters.

and sent to the smelter; the last five spitzkasten make a middling which is returned to the original feed of the machines. The spigot product from the last spitzkasten is a final tailing, which is rejected. I might say that the 20 machines are fed in parallel. The oil used in the treatment of the slime consists of about three to three and a half pounds of sludge acid kerosene per ton of slime treated and about two and a half to three pounds of wood creosote, and about 15 pounds of 60° Be. sulphuric acid per ton treated.

Q. 10. What is the capacity of the slime flotation plant?

A. The capacity is about 3000 tons.

Q. 11. What does the feed to that plant consist of?

A. The total feed consists of the current mill slime, which I have just described, plus a thousand tons, approximately of what we call dump slime. This dump or pond slime is slime which has been accumulated from the time the plant started in 1902—the original plant, and it has been accumulated in ponds and is now being returned for treatment by flotation.

Q. 12. Describe a little more in detail the concentrate de-watering plant.

A. The concentrate de-watering plant consists of three buildings, using 50x12 Dorr tanks of the standard type. The upper building, called No. 1, treats the concentrate produced in the main mill and delivers that to six tanks. The overflow from this building passes to what we call the No. 3 building, which contains 10 fifty foot tanks, and the overflow from this

Albert E. Wiggin.

building passes to the ponds, as it still contains a small amount of concentrate which has not settled out. This concentrate is settled in the ponds, and is being brought back and will be subsequently brought back for treatment in the smelter. The slime flotation plant concentrate passes to the No. 2 de-watering building, which consists of five 50-foot tanks. The overflow of this building goes, with the No. 1 building overflow, to the No. 3 plant. The spigot discharges of all these tanks pass to 13—12 ft. I should say 11½ ft. diameter by 12 feet face Oliver filters. The filtrate water from these filters passes to the ponds, in order to save any concentrate it may contain, although it is practically clear water, while the cake passes on to a conveyor and is thence taken to the smelter for treatment.

Q. 13. What you have described thus far is the copper concentrator plant?

A. The copper concentrator plant.

Q. 14. There is also a zinc concentrator plant?

A. Yes, there is.

MR. KENYON: I will now offer in evidence the two flow sheets introduced by the witness.

Flow sheets admitted marked PLAINTIFF'S EXHIBITS Nos. 242 and 243.

Q. 15. Will you please describe the zinc concentrator?

A. I have here a flow sheet of the large zinc ore concentrator which will facilitate the description. This

concentrator is designed to treat 2,000 tons of ore per day.

Q. 16. State first when it was erected.

A. The erection was started in December of 1915 and completed in August of 1916, and the mill put into operation at that time.

Q. 17. And what ore does it treat?

A. It treats the zinc ore from the Butte mines, together with a small amount of custom ore from other districts. This concentrator was designed to treat 2000 tons of ore. The crushing division is a duplicate of the crushing division of the copper mill, the ore being crushed through two millimeters, and the only difference being that in the zinc ore concentrator there are no jigs or tables. The crushing division simply crushes the ore through 2 millimeters and delivers it to the grinding division.

Q. 18. There is no water concentration at all in the zinc concentrator?

A. There is no water concentration there. The grinding division consists of seven Hardinge mills, of which five are used. These mills are the same design as those used in the copper mill, 7½ feet in diameter, with six foot cylinders, using balls. The material is ground through approximately a .25 millimeter, and is then sent to the flotation division. The flotation division consists of six standard type Minerals Separation machines of the same design as those in the copper mill. The oil and acid is added ahead of the concentration machines. The following amounts of oil

are used, these figures being the averages for January, 1917, and are fairly representative of our practice:

Sludge acid kerosene .7 pounds per ton of feed to the flotation division; wood creosote 2.7 pounds. This creosote at the present time is a mixture of Cleveland Cliff hardwood creosote, and a creosote which we are getting from either the Georgia Pine Turpentine Company or the Pensacola Company of Florida, a mixture of about half and half. The amount of sulphuric acid used is 22.7 pounds of 60° Be.

The overflow from the first spitzkasten of the six primary machines is a finished concentrate. The overflow from the next eight spitzkastens is what we call a rougher concentrate and goes to the two cleaner machines. These cleaner machines are the same type as the six roughing machines. The last five boxes make a middling which is returned to the primary machines. The spigot from the last box of the rougher machines is a final tailing and is sent to waste. The cleaner machine~~s~~ makes clean concentrate from the first seven boxes and a rougher concentrate from the last seven boxes which is returned to the feed of the cleaner machine~~s~~. The spigot from the last box of the cleaner machine is a middling which is returned to the feed of the rougher machine. The cleaner concentrate is settled in five fifty foot Dorr tanks, the overflow from these tanks being slightly muddy, is returned to the system as sluicing water. The spigot product is sent to an Oliver filter where it is dewatered, the cake going to the cars for shipment to the zinc plant and the

filtrate being returned to the system. That briefly describes the zinc ore concentration.

MR. KENYON: The plaintiff puts in evidence flow sheet produced by the witness and the same is marked plaintiff's exhibit 244.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 244.

Q. 19. Will you please state now a little more in detail what is the practice with regard to returning middlings?

A. In the copper mill in the treatment of what we call the sand feed, which is a product from the grinding mills, we make a clean concentrate from the first seven boxes of the machine and from the last seven boxes we make a middling which is returned to the head of the system, of the flotation system. In the slime concentration we make a finished concentrate from the first 9 spitskasten and we return as middling to the head of the system the overflow from the last 5 spitzkasten. In the copper mill it will be noted that we use no cleaner machines at all. In the zinc concentrator we use cleaner machines, giving the concentrate one cleaning. The first machines or primary machines make a finished concentrate from the first spitzkasten, and the next eight spitzkasten make a rougher concentrate which goes to the cleaner machine and the last five spitzkasten make a middling which is returned to the feed to the primary machine, the spigot discharge from the last spitzkasten being a tailing. The cleaner

Albert E. Wiggin.

machines make cleaner concentrate from the first even spitzkasten, and a rougher concentrate or middling product from the next 7 which is returned to the cleaner machines, and the spigot products from the last spitzkasten on the cleaner machine is returned to the primary machines and mixed with feed.

Q. 20. Do you ever take into account the oil contained in the returned middlings in determining the consumption of oil in the process?

A. We do not.

Q. 21. Why are middlings returned to the head of the same machine when they are so returned?

A. Why, the middling really acts as a safety, you might say, between the concentrate and tailing, much the same as in the operation of a table it is not feasible to make a clean-cut concentrate and a clean-cut tailing. The recovery will be higher by cutting out a portion in between which is a little too rich to go as a tailing and a little too clean to go as a concentrate and returning that to the feed, thus making a circulating load. And, for the same reason, we return middlings in the flotation process.

Q. 22. Does that return of middlings result in economy of oil in the total process so far as you have observed?

A. No.

Q. 23. In the matter of consumption of oil in the total process so far as you have observed, does it make any difference whether middlings are returned to the

Albert E. Wiggin.

head of the same machine or are returned to a cleaner machine?

A. I have observed that it makes no difference.

Q. 24. You have spoken of a round table plant having been scrapped as an incident in the installation of the copper concentrator. Can you give us from the records of the company the total value of the entire plant that was scrapped to make way for this installation?

A. Of the entire round table plant?

Q. 25. Yes.

MR. KREMER: We object to that as incompetent, irrelevant and immaterial and meeting no issue in the case.

THE COURT: It tends to show the displacement, the success of this system displacing others which seems to be a consideration. The objection will be overruled.

MR. KREMER: Exception.

A. I understand that you want the value of the round table plant displaced?

Q. 26. MR. KENYON: Of all the plant that was displaced and scrapped and made useless by the installation of the copper concentration plant?

A. The dismantled value of the round table plant which was displaced by the flotation after 21 months operation was $260,261.32. From this must be subtracted a value of $31,451.27 for the use of this building in the electrolytic zinc plant, leaving a net dismantled value of $228,810.05. The dismantled value of the main concentrator replaced by flotation, as it

Albert E. Wiggin.

appears on the books of the company today is $630,-288.18, making a grand total, including the round table and the main copper mill of $859,098.23.

Q. 27. You have given, I believe, the oils, both as to character and quantity, that have been used in the flotation mill operations, both in the copper concentrator and in the zinc concentrator, have you?

A. I have given them approximately, yes, in my description.

Q. 28. Have you ever in your experience noticed or known as a fact that where the percentage of sulphide minerals in flotation feed increased the amount of oil had to be increased?

A. I have not.

Q. 29. Have you ever followed any such rule of practice?

A. We have not.

Q. 30. Have you figures that would illustrate the contrary of that?

A. I have here some figures made up from the month of January, 1917, showing the amount of oil used in the treatment of copper sand and of copper slime and of zinc ore. I might state here that in describing the copper mill I omitted to say that a certain amount of slime is returned to the main mill for treatment with the sand. All of the slime does not go to the slime plant. I also have the—

Q. 31. (Interrupting.) About what amount is returned approximately?

Albert E. Wiggin.

A. About one-third of the slime produced is returned to the main mill for treatment.

Q. 32. About one-third of the current slime?

A. About one-third of the current slime. The remaining two-thirds passes to the slime flotation plant. The total sulphide contained in the three products, that is the copper sand, the copper slime, and the zinc ore for the month of January, taken from our assay sheets is as follows: The copper sand contained 10.3 per cent total sulphide; the copper slime contained 12.8 per cent total sulphide; and the zinc ore contained 38.6 per cent total sulphide. The amount of oil used in the three cases was as follows: The copper sand, total oil, 3.5 pounds per ton of feed treated by flotation; copper slime 5.5 pounds; and the zinc ore 3.4 pounds. That is the zinc ore which contains very nearly four times as much total sulphide as the copper sand used one tenths of a pound less total oil per ton of ore treated. The amounts of acid used were as follows, based on 60° Bc. sulphuric. Copper sand 6.8; copper slime 13.8 and zinc ore 22.7 per ton of ore treated by flotation.

Q. 33. Why did the copper slime require more oil than the copper sand?

A. I presume that it was due to the presence in the slime of considerably more aluminous clay material which probably absorbed the oil and I presume rendered it useless for flotation purposes.

Q. 34. Now as to the extent of use of this flotation process at the Anaconda mill, will you please as an example give us from the official records of the company

Albert E. Wiggin.

the total tonnage fed to the copper concentrator for the year 1916, of ore for concentration treatment?

A. The total tonnage of copper ore treated during the year 1916 in the copper mill was 5,030,350 tons containing 296,112,514 pounds of copper.

Q. 35. And what percentage of that amount of copper was actually recovered by mill operations during that year?

A. There was actually recovered of this copper 95.448 per cent.

Q. 36. Now, as to the flotation part of the operation that year, leaving out the wet concentration operations of the upper part of the mill, what was the total feed to flotation from newly mined ore during 1916?

A. The total feed to flotation?

Q. 37. I refer to the copper concentrator of course.

A. The copper mill, the total feed to flotation in the copper mill during 1916 from newly mined ore was 3,800,750 tons.

Q. 38. The copper content of that tonnage?

A. Containing 106,339,156 pounds of copper.

Q. 39. And what was the tonnage of the concentrates recovered by the flotation plant?

A. The concentrate recovered by the flotation plant from this feed amounted to 576,417 tons containing 99,962,700 pounds of copper.

Q. 40. What was the percentage of recovery by that part of the plant, the flotation part?

A. The percentage of recovery of the flotation

plant was 94 per cent of the copper contained in the feed to the flotation plant.

Q. 41. Now, as to the zinc concentrator, what was the total tonnage from the time the zinc concentrator started operation until the present time—I believe your figures are down to the present time, are they not?

A. Yes. The total ore treated by the zinc concentrator from the time the small concentrator started in January, 1916, up to April 1st of the present year was 292,493 tons, containing 78,308,337 pounds of zinc.

Q. 42. What was the recovery of the zinc in percentage of the zinc in the feed to the zinc concentrator?

A. The recovery of the zinc in the zinc concentrator during this period was 92.8 per cent.

Q. 43. What was the grade of that zinc?

A. Approximately 33 per cent zinc.

Q. 44. Will you tell us please what use is made of that concentrate, what value it has?

A. This concentrate is roasted and then treated with dilute sulphuric acid, the zinc going into solution and from the solution the zinc is later precipitated electrolytically.

Q. 45. What is then done—where is that done?

A. The roasting is done partly in Anaconda and partly in Great Falls. The leaching and electrolytic work is done entirely in Great Falls.

Q. 46. Has zinc of that grade any value for smelter purposes, ordinary smelter purposes?

A. I understand it has not.

Albert E. Wiggin.

Q. 47. Its value then is dependent upon the electrolytic process by which the zinc is purified?

A. It is.

Q. 48. Prior to the installation of the flotation plant which you have described how was the concentration effected at the Anaconda mill?

A. You refer to the copper mill?

Q. 49. The copper mill, yes.

A. The concentration was effected entirely with jigs and tables, with a round table treatment of slimes coming in about 1914.

Q. 50. Entirely water concentration?

A. ~~The same thing.~~ Entirely water concentration

Q. 51. I believe, Mr. Wiggin, you have not given us the grade of the copper concentrate that is produced in the copper concentrator. Have you those figures for the year 1916?

A. You mean the total concentrate?

Q. 52. The total concentrate from the copper concentrating mill?

A. The ~~mill~~ total concentrate from the copper concentrating mill for the year 1916 had the following analysis: Per cent copper 8.072; ounces of silver per ton 5.186; ounces of gold per ton .0168; per cent SiO2 22.8; per cent FeO 33.7; per cent sulphur 32.8; percentage Al203 5.2; CaO .2.

Q. 53. You say that the grade of the copper concentrate, so far as the copper is concerned, is 8.07?

A. Yes.

Q. 54. Is that a low grade?

Albert E. Wiggin.

A. No, that is a grade of concentrate which is suitable for our smelter. It would be considered low copper in comparison with ores carrying less iron than the Anaconda ore carries. The Anaconda ore carries a great deal more iron than ores in Utah and Arizona for example. There the concentrate may run as high as 20 to 30 per cent copper, but the insoluble would be about the same as our insoluble. This concentrate is concentrate which is most suitable for smelting treatment at our plant. If we made it any cleaner it would be an expense to us to add silica to it. I might say that we could make any grade of concentrate we desired, that is up to a point where we eliminated all free silica.

Q. 55. You purposely seek to attain about the grade 8.07?

A. We do. I might explain that the grade is not based on the copper, it is based on the content in iron and insoluble, and the copper takes care of itself.

Q. 56. Will you now, from the original records of the company, let us know what the total tonnage of ore treated was from the time the mill was started until the 31st of December, 1915, which you say was by water concentration?

A. The Anaconda concentrator first started operations in February, 1902, and the total amount of ore treated from that time through December 31st, 1915, was as follows: 35,877,044 tons containing 2,408,629,436 pounds of copper.

Q. 57. Of this copper content, how much was actu-

Albert E. Wiggin.

ally recovered by the processes of concentration that were actually employed?

A. There was actually recovered as concentrate through December 31st, 1915, 11,893,536 tons.

Q. 58. Translate it into pounds?

A. That is the tons of concentrate, containing one —containing 1,885,859,368 pounds of copper.

Q. 59. On December 31st, 1915, what had this water concentration process resulted in in the way of rejects then present and existent in the valley below the mill? Answer from the records of the company?

A. The sand tailings produced in the mill were piled just below in the valley and it is estimated that that pile contained on Dec. 31st, 1915, 17,000,000 tons of tailing, carrying .65 per cent copper, or a total of 221,000,000 pounds of copper. And in addition to that there had been saved a certain amount of slime from the mill before the round table plant was installed and it is estimated that the slime pile on the first of January, 1916, contained the following tonnage: 833,758 tons, containing 36,031,725 pounds of copper.

Q. 60. And are those the slime tailings that you are now treating in the slime plant at about the rate of one thousand tons per day.

A. They are.

Q. 61. Now, assume that through the years from 1902 until the 31st of December, 1915, on the tonnage that was actually treated at the mili by water concentration, from year to year, the processes actually operating in your copper concentrator during the year 1916.

and giving the recoveries then made had been applied and utilized, what would have been the additional recovery of copper from that tonnage over and above the recovery that was actually made, the figures of which you have given us?

MR. KREMER: To which we object for the reason that it is incompetent, irrelevant and immaterial for any purpose, as it would not even tend to prove that which counsel had offered it to prove, namely, utility. For the further reason that it has not been shown that the witness knows the various processes which have been conducted in the plant of the Anaconda Company since the plant started or since the first date mentioned, February 1st, 1902.

THE COURT: Well, it is merely another way of getting at what could be gotten out of those tailings by flotation: Perhaps he has given enough data already, but I think he can answer. The amount of weight it is entitled to is another question. Objection overruled.

Defendant excepted.

A. In answering your question I might say that in giving the total copper recovered by water concentration from the time the mill started in 1902 through December 31st, 1915, I gave the total pounds of copper that was recovered in the form of concentrate and treated in the smelter. I might add to that the amount of copper that had been recovered in the form of slime in the ponds and returned to the smelter for treatment, and also the amount of copper that had been recovered from the tailing pile by the leaching process up

Albert E. Wiggin.

to January first, 1916, which will give a total recovery of copper up to that time of 1,945,977,851 pounds. Now, if we take the tonnage of ore treated during this period, which was 35,877,044 tons, containing 2,408,-629,436 pounds of copper and apply to it the recovery which was actually made in our concentrator during the year 1916, the flotation process having been in full operation during the entire year—

Q. 62. What percentage?

A. A percentage of recovery of 95.448, which was the actual recovery for the year 1916—we would have recovered from this tonnage of ore containing the given amount of copper, 2,298,988,624 lbs. of copper, or an excess recovery if we had used the process of flotation which we now have during this entire period, over and above the recovery which we actually made, including what slime has been smelted and what tailing has already been leached—an excess recovery of 353,-010,773 lbs. of copper.

Q. 63. What would have been the value of that copper at the average market price for copper current during that terms of years, figured with reference to the tonnage treated at the mill from year to year, less a reasonable charge for the cost of treatment?

A. If we determine the average price of copper for that period as applied to copper produced at Anaconda by taking the average yearly quotations from the Engineering and Mining Journal, which is considered a standard, and apply these yearly quotations to the pounds of copper treated during that year, and then

Albert E. Wiggin.

average the entire period, from 1902 to 1915 inclusive, we get an average price for copper of 14.8 cents per pound. If we deduct from this 4 cents to cover the treatment charge for smelting and converting, that leaves a net value of 10.8 cents per pound, and applying this value to the three hundred and fifty-three million pounds of copper which we would have recovered if we had had the flotation process in operation, gives a total value for this copper of $38,125,163.00.

Q. 64. Would that allowance for the cost of treatment be liberal?

A. I think four cents is a liberal allowance—that is four cents per pound of copper recovered is a liberal allowance for smelting and converting of the concentrate. I might say that the refining and marketing charge would be taken care of by the amount of silver which would have been recovered, and which we are neglecting in this calculation. That would amount to approximately 2 cents per pound of copper.

Q. 65. Now, you say that on January 1st, 1916, there was in the slime ponds as a reject of prior processes, according to the record of the company, 83~~5~~3,758 tons?

A. Yes.

Q. 66. Containing 2.16% of copper?

A. Yes.

Q. 67. Totaling 36,031,725 pounds of copper?

A. That is right.

Q. 68. Now, valuing that as an asset today from the point of view of its susceptibility to recovery of

Albert E. Wiggin.

that copper by the flotation process at present practised in the mill, what would be a fair percentage of recovery attainable on those lines?

A. If we consider that these slimes at present contain some oxidized copper, having been exposed to the weather for a good many years, we can figure, I think, safely, a .5% copper tailing in the treatment of this slime. I might say that in the treatment of the current mill slime which has not been exposed to the weather our tailing averages around .25 to .30% copper, so I think .5 is a liberal allowance. And assuming that a 12% copper concentrate, with a feed running 2.16, which is the content of the slime, and calculating the recovery, we find that from this slime we will recover in the form of concentrates 28,800,000 pounds of copper. If we assume a 20 cent market for this copper (and I might say that part of this copper has been recovered during 1916 and so far in 1917 and the rest of it will be recovered in the next 20 months approximately so that probably 20 cents would be a fair market value for the copper, considering the fact that it has already sold above 30 cents for part of the period and if we subtract from 20 cents 6 cents a pound to cover the cost of treatment and smelting and converting and allow the silver content, which would amount to approximately 2 cents a pound, to take care of the refining and selling, that would leave us a value of 14 cents a pound for this copper. That would make the 28,800,000 lbs. of copper worth $4,032,000.

MR. KENYON: The witness is yours.

Albert E. Wiggin.

CROSS-EXAMINATION.

BY MR. SCOTT:

X-Q. 69. Mr. Wiggin, you gave some figures, I think, of January, 1917, on the amount of oil and acid relative to sulphide in the copper slime, copper sand and zinc mills. Was that with reference to January, 1917?

A. Yes, January, 1917.

X-Q. 70. Now, can you furnish a daily record for that month of the different plants, showing the amount of these different reagents and also the dilution of the pulp and the assay of heads, concentrate sand tailings, daily?

A. I can furnish a daily record of the amount of oil used, but I might explain that in this way: that the amount of oil used on each shift is determined by the operator—by what we call the reagent man, by making measurements in the reagent tanks. These measurements are not accurate; they are approximate. At the end of the month we average these different determinations, and compare them with the actual amounts of oil used as measured from the large storage tanks. Then we distribute the actual amount used between the copper sand and copper slime in proportion to the daily readings, and I would say that these daily readings do not check exactly the actual amounts used, as it is impossible to make an accurate reading in the reagents, but they do check fairly closely. The total amount of oil used from the large storage tanks is de-

Albert E. Wiggin.

termined accurately, and the distribution is made in accordance with the daily shift readings of the reagent men.

X-Q. 71. You mean that the oil consumption shown by these daily readings does not check up with the actual amount of oil consumed as shown by the readings on the big tanks?

A. Not exactly, no.

X-Q. 72. How near?

A. Well, I have a month here; take this month of January, and consider the sludge, for instance, in the treatment of the sand in the concentrator. The average of the daily readings is 3.25. The average of the actual pounds, as calculated from the storage tanks and distributed in proportion to the average of the daily readings, is 3.37; 3.25 against 3.37. The creosote is .30 against .27.

X-Q. 73. Do you keep these shift figures so that you can produce them so that there would be a way of comparing the amount of oil used upon each day?

A. We keep these figures for one month back, and I am not sure whether I could get January or not. We have two copies made; one is sent to me and the other is kept by the operating superintendent, and we keep them for one month back. The reason we do not keep them longer is because they become too bulky.

X-Q. 74. These figures that you gave are monthly averages?

A. They are the actual monthly averages.

Albert E. Wiggin.

X-Q. 75. Can you give those daily figures for an actual month?

A. I can give them for any month.

X-Q. 76. Those figures are the only ones that would enable any comparison to be made with reference to the relation of oil and acid to sulphide on the same ore from day to day, aren't they?

A. Well, you mean the daily readings are the only ones?

X-Q. 77. Yes; otherwise we would have to proceed with the monthly averages over a long period of time, wouldn't we?

A. Yes; but this month of January is typical. I am sure that any other month would show practically the same relation. I would be glad to get them if you desire.

X-Q. 78. Well, do that then, please.

A. What month would you like?

X-Q. 79. This month, last month, or the month before?

A. Just one other month?

X-Q. 80. Yes.

A. March or February?

X-Q. 81. March will do. And the assay of heads, tails and concentrates as to iron, copper and insoluble, in the case of the copper.

A. We do not determine all those things daily. I will tell you how we get those assays; the samples for each day are saved until the end of the month. The copper is determined daily, but the analysis is determ-

Albert E. Wiggin.

ined oncé a month on the combined samples made up from the daily samples.

X-Q. 82. Well, you can give me the copper daily?

A. I can get the copper daily.

X-Q. 83. That will be the copper in the heads, tails and concentrates?

A. Yes, I can give you that daily.

X-Q. 84. And with those—will those figures show the dilution?

A. I don't know whether we keep the density of the pulp in the slimes plant now. We used to keep it, but I don't think we do now.

X-Q. 85. And in the sand plant?

A. I am not sure; I don't think we keep it now.

X-Q. 86. How about the zinc plant?

A. We don't keep that daily, I am sure; we have kept all those figures over different periods of time until they had served their purpose. The density in the slime concentrator varies a great deal, because we are treating the dump slime there, bringing back a thousand tons dry a day. The density in the sand plant varies very little. The density in the zinc concentrator varies considerably.

X-Q. 87. You have a leaching plant in operation, haven't you?

A. We have a copper leaching plant.

X-Q. 88. And was that in operation before flotation was introduced?

A. I will just make sure of that. The leaching plant was put into operation in May, 1915, and the first sec-

tion of the concentrator remodeled for flotation was put into operation just about the same time, but I could not say exactly whether it was after or before.

X-Q. 89. The leaching plant is still operating?

A. It is still operating.

X-Q. 90. Efficiently?

A. Yes.

X-Q. 91. What material are you treating in the leaching plant?

A. The accumulated sand tailings.

X-Q. 92. The same material that is in the sand department of the flotation, the sand copper—

A. Well, it is not exactly the same material. The material that we treat by leaching is the 17 million tons referred to in my testimony as having been accumulated from the mill. It is a tailing made on jigs and tables in the old water concentration system.

X-Q. 93. And by leaching you are attacking these 17 million tons?

A. Yes.

X-Q. 94. By the way, what is stove oil; I forgot to ask you; it is a petroleum oil, isn't it?

A. I understand so, yes.

X-Q. 95. Is that one of the oils that you are using in flotation?

A. We don't use it now, no; we used it in the experimental work.

X-Q. 96. What are you using now?

A. We use sludge acid, kerosene and creosote oil. It is a hardwood creosote. We also use sulphuric

P. 4315, L. 30, after "sludge" insert "from the Standard Oil Company, we got a sludge"

Albert E. Wiggin.

acid. In the treatment of the sand we sometimes use creosote and sometimes not. At the present time we are using nothing but sludge acid kerosene.

X-Q. 97. How about the zinc plant?

A. In the zinc plant we use creosote. We use nothing—we have used nothing but Cleveland Cliff creosote and sludge acid kerosene. At the present time we are using sludge acid kerosene and a mixture of Cleveland Cliff creosote and the creosote which we get from the Pensacola Company; it is their No. 350 oil, I think.

X-Q. 98. In the testing period that you have told about you used several different petroleum oils, stove oil and some others?

A. Yes, in the testing period we used several different forms of sludge acid, too, obtained from different refineries.

X-Q. 99. And these petroleum oils produced the result aimed at, didn't they?

A. No.

X-Q. 100. That is, notwithstanding that you have found others that you think better?

A. No, not all of them; some of them gave us very poor results.

X-Q. 101. Which ones gave fairly efficient results?

A. The only two sludges, that gave good results were a sludge from the ~~United~~ Union Oil Company, and a sample that we obtained from the Standard Oil Company. T~~he latter,~~ When we tried to duplicate this latter sludge, which gave us very poor results.

X-Q. 102. You referred to using—my note looks as

if it was crude oil. Did you ever use crude oil and stove oil?

A. I don't think we ever used crude oil. Fuel oil is sometimes called crude oil; we have tried that.

X-Q. 103. Argol, what is that?

A. That is a tartrate.

X-Q. 104. It is a chemical?

A. Yes.

X-Q. 105. Have you got any results which you obtained using stove oil and fuel oil, either alone or in a mixture?

A. Yes, we have all those results; I think those results were given in the paper I published in the A. I. M. E. If anyone has a copy of that here—

X-Q. 106. Here is a copy.

A. Well, this does not show it either, because this is a summarized account of our work, and in order to show the results we got in our first preliminary period I would have to go back to the original company records, which I can do. This paper shows results when using stove oil, but I might say that we never considered stove oil as a flotation oil—and we do not use it now and have not used it since the plant started on large operations.

X-Q. 107. When the middlings are sent to he cleaner or the rougher concentrate whatever it is called, do you add any extra oil to treat that in the cleaner?

A. No. You refer to the zinc concentrator?

X-Q. 108. Yes. Then how is it that the oil and middlings which are returned to the head of the rough-

Albert E. Wiggin.

er machine have no effect in helping along flotation; I don't know that you put it just that way, but that was the impression I got.

A. I could not say whether it has any effect or not. We do not consider it in our computations of the amounts of oil used.

X-Q. 109. In fact you have no reason to segregate out the effect of the oil coming from this source, from the middlings, from the new oil; all you are concerned with is just how much oil you have to add?

A. We have no reason to segregate it and never have determined it.

RE-DIRECT EXAMINATION.

BY MR. KENYON:

R-Q. 110. Mr. Wiggin, this kerosene sludge or sludge acid kerosene as it has been variously called —is that kerosene?

A. No, that is a by-product from the refining of kerosene.

R-Q. 111. Does it contain kerosene?

A. It may contain a small amount of kerosene.

R-Q. 112. Not in any notable extent?

A. It certainly would not contain kerosene to any extent, because the refineries could not afford to lose their kerosene in that way. It is simply the impurities taken out of the kerosene, and it is sold at a very cheap price. We have never detected any kerosene in

Albert E. Wiggin.

it, although we have detected a colorless liquid at times in some of the shipments, but I could not say what it was. It was not kerosene.

R-Q. 113. Is the solid feed to your copper flotation plant constant or is it variable in character?

A. It is quite constant; the only variation is due to the human element variation in ~~treating~~ feeding; that is we have men feeding the ore, to the mill, and there is a certain variation due to that.

R-Q. 114. This leaching plant that you have spoken of, it is a plant of considerable extent and cost?

A. Yes, it is a plant that will treat about 2500 tons of sand tailings a day by the leaching process.

R-Q. 115. What was it originally built for particularly?

A. It was built originally to treat the sand tailings as produced from the mill the current tailings.

R-Q. 116. About how long before the M. S. flotation process?

A. The testing work and the idea of building the plant all came before we tested flotation.

R-Q. 117. And when flotation was tested it was substituted ~~submitted~~ as the process~~,~~ and the plant for treating the current mill tailings, was it?

A. It was.

R-Q. 118. And this leaching plant was diverted to the purpose that you have mentioned?

A. It was.

R-Q. 119. Now, one more matter. You have

Albert E. Wiggin.

spoken of a round table plant. Did that involve an invention of your own?

A. Well, partly, yes. The patent for the round table is partly in my name.

R-Q. 120. You were a joint inventor with some-one else?

A. I was.

R-Q. 121. And it was patented?

A. It was patented.

R-Q. 122. And was it better or worse than prior water concentration processes?

A. It was better than any other machine we tried, and we tried, I think, all the modern slime concentrators.

R-Q. 123. And had you hopes of reward and perhaps wealth from that invention?

A. I had some hopes until flotation came along.

R-Q. 124. What did flotation do to it?

A. It put it out of business practically. The best we could do on the slime with the round table was about a 1.1 of Cu. tailings, and in our experiment with the flotation process, we got tailings as low as .15, and we are at present making tailings running around .3 from the current slime, and in one month the tailing ran as low as .23 when treating slime.

R-Q. 125. Was this round table invention installed anywhere else, or used anywhere else?

A. It was not.

R-Q. 126. Was it about to be at that time?

A. We were just starting to put the table on the market when flotation became known through this part of the country and was being adopted.

R-Q. 127. And you then desisted from that effort?

A. We did, yes.

WITNESS EXCUSED.

WILLIAM MASON GROSVENOR, resumed the stand, testified as follows:

RE-DIRECT EXAMINATION,

BY MR. WILLIAMS:

R-Q. 176. There was some uncertainty in my mind as to the meaning of your testimony relative to the effectiveness of a single adsorption layer in producing attachment and flotation. Will you explain this more fully?

A. If, as I understand it, a single adsorption layer would appear at—let us say the interface between the pulp and the bubble—if there were only such a layer, or, to put it in another way, if the layer were only of the thickness that would be regarded as a single adsorption layer, the effect would in my opinion be substantial ly direct attachment to the air in the sense that such a single layer would be formed I think, not with oil—that is speaking of oil as I defined it, an insoluble matter. With the insoluble matter, it is my conception that there must necessarily be two adsorption layers, that the oil must have on the one side of it the

air, on the other side of the aqueous pulp, and that those two interfaces each, in every definition which has been used by the experts for the defense, must be regarded as an adsorption layer. Then if now we assume the amount of oil to be increased beyond the mere presence of these two layers, we get the slight amount of oil in bulk as distinguished from layer oil present between these two layers, and that it is more or less free to move about the bubble as described by Prof. Bancroft, seeking one portion or another of the bubble, moving between these two layers. In my cross examination I may have spoken of the effect of an adsorption layer on promoting attachment. I understood the question then to be the effect in promoting the coming of a mineral into the interface, whether it is a single or a double interface. I do not disagree with the statement that the presence of such a layer promotes readiness of attachment, merely that it decreases the force of such attachment. Speaking of the amount of oil, I feel that the presence of oil between these two interfaces (permitting this movement of oil around the bubble) may be so small as to be negligible, so far as accumulating a mass of material on one side of the bubble is concerned. And the point of necking out of which I have spoken, is the point where that amount of oil in bulk between these two layers becomes sufficient to permit the outer layer to be separated so far from the inner layer that a strain upon the particle (owing

to the sudden movement of the bubble), permits the oil to neck outward and draw off into a thick neck, which has relatively as indicated in my testimony on direct, perhaps five miligrams of attachment power as compared with 30 or 40. Does that make it intelligible?

R-Q. 177. The 30 or 40 mm. being applicable to what condition?

A. To the condition where there was in the case of 30 substantially no excess of oil between the layer: and in the case of 40 substantially no oil at all.

WITNESS EXCUSED.

IRA L. GRENINGER, recalled, testified as follows:

DIRECT EXAMINATION,
BY MR. KENYON:

Q. 1. Mr. Greninger, on April 29th, 1917, you were one of a party representing the plaintiffs here who visited the defendant's mill?

A. I was.

Q. 2. And on that day you inspected the process there in operation?

A. I did.

Q. 3. Will you please describe that process as you saw it and briefly what you observed with respect to it?

A. I think the flow sheet has already been proved by the defendant's witnesses.

Ira L. Greininger.

Q. 4. What is the exhibit number?

A. Defendant's exhibit 222. On the day that we inspected the plant I found the flotation feed after having passed from the wet concentration section of the mill, was reground and divided into seven cuts each one of the seven portions going to one of the machines heretofore referred to as pyramid machines or roughers. These machines produced a rougher concentrate on the first three spitzkasten, which was quite slimy and apparently very low grade for a zinc concentrate; and this concentrate was retreated on the first of the retreaters which is marked on this exhibit "No. 1 cleaner." The tails from these machines were returned to the roughers or the elevator which distributed the original feed and the middlings to the roughers. The concentrate from this first cleaner was retreated in the second cleaner which is one of the pyramid machines which is marked on this exhibit "No. 2 cleaner." I think the first three spitzkastens of this machine, that is the product from the first three spitzkastens, was carried to the third and final cleaner which produced finished concentrate, the fourth, fifth and sixth and seventh spitzkasten on each of the pyramid machines produced a middling, the water level being very high in these spitzkasten, and a great amount of gangue slime was carried over with the mineral and was returned to the head of the pyramid machine or roughers.

Q. 5. What was the effect of a very high level of water in these last four spitzkasten?

Ira L. Greininger.

A. It carried a very large portion—it in any case or all cases where such a level is maintained, carries a large portion of gangue slimes, that is the finer particles of gangue and clayey material that was contained in the ore, back to the original feed where it would be mixed with the new feed. Finer particles of gangue, slime and the clay floating near the surface of the water would be carried over and go back with the middlings. Anything floating near the surface of the water would go over under those conditions. This overflow of gangue slimes would be still further increased by tailings returned from each of the cleaners and the overflow from the final treatment of the ore which was had in a set of Callow cells. The concentrate from this Callow cell which was undoubtedly very low in grade, although I do not know the grade, would also carry a large percentage of gangue slimes which was also returned to the head of the rougher machines. Does that wholly answer your question?

Q. 6. You say that there was a very large quantity of middlings. In comparison with what was the quantity very large?

A. In comparison with the total of new feed, and was apparently by the amounts carried over, especially by the spitzkasten of the pyramid roughers, that is the 4th, 5th, 6th and 7th spitzkasten.

Q. 7. Enumerate again if you will the several sources of the middlings returned as the plant was operated that day?

Ira L. Greininger.

A. The 4th, 5th, 6th and 7th spitzkasten of each pyramid rougher.

Q. 8. Of each one of one to seven?

A. Yes, of each one of one to seven, the tails from each of the cleaners and the overflow from the Callow cells, where the tailings from the pyramid machines received their final treatment.

Q. 9. The finer parts of the gangue, the finer and lighter parts of the gangue, the clays for example, in the gangue, clays of the pulp would have a tendency to accumulate in this returned feed circuit, would they?

A. I think they would have a tendency to build up to an extent far in excess of the amount of such material carried in the original ore.

Q. 10. Had you any means of judging of the relative quantity of returned middlings fed to the head of the machine as compared with the new feed to the head of the machine?

A. Not visually.

Q. 11. Was it an unusually large quantity?

A. That is I mean by that, not where the two streams joined, I didn't see that where the two streams joined. The quantity was unusually large by observing them at their sources—That is where they left the spitzkasten, but a comparison of the two streams where they joined, I did not see. I did not see them at that point.

Q. 12. As compared with standard M. S. practice

with which you have been familiar was the amount of that return middling large?

A. Yes, very much larger than ever I had seen used in my experience.

Q. 13. Very much larger than any you have ever seen used?

A. Yes.

Q. 14. Now please describe the concentrate that came over from the first spitzkasten of the first cleaner machine to each rougher machine from the point of view of your knowledge and experience of standard Minerals Separation practice?

A. The concentrate was a mineral froth, I would say a typical froth of the patent in suit, with indications of a degree of over-oiling, the degree of over-oiling did not seem so marked as I would have expected knowing the condition of oiling at that time and knowing the amount of oil being introduced into the plant.

Q. 15. What were these conditions of over-oiling?

A. Well I think the records show that the amount of oil added to the ore per ton on that day was something like 26 pounds.

Q. 16. And what were these indications of over-oiling that you speak of observing?

A. It was a sort of glassy appearing film on the concentrate—that is on the froth as a whole.

Q. 17. How did the consecutive froths compare with one another in that regard, the first, second and third of each rougher machine?

A. The first, second and third were very much alike to my recollection. Of course after the third spitzkasten had been passed the conditions were altogether different in the fourth. There was no chance for comparison between those two, between the third and fourth?

Q. 18. Now, how did the appearance and character of the froth in the 4th, 5th, 6th and 7th spitz kastens appear with that in the 1st, 2nd and 3rd of the rougher machine?

A. The froth in passing off so fast in such a great volume of water did not give time for it to accumulate in any way that would make it possible to compare the two, where the froth was formed. It seemed very low grade and whitish in appearance, and was carried over, as I stated before, with a large amount of water.

Q. 19. From your observation of the process as practiced in the mill that day and the experience you have had with standard Minerals Separation practices, what is your opinion as to the identify or nonidentity of the two processes?

A. I consider the process was that of the patent in suit.

Q. 20. You regard the two processes as substantially identical?

A. I do.

Q. 21. And the results you observed on that day as compared with the results with which you are

familiar in standard Minerals Separation practice, how do they compare? Were they substantially the same in kind or substantially different in kind?

A. Substantially the same in kind although the grade of zinc in the final concentrate was not what one would expect from the first class practice but was combined with a vast amount of slime which was returned in all cases. While some of this slime is dispensed with it cannot all be thrown out and some of it is bound to go with the concentrate, making a low grade zinc concentrate.

Q. 22. From your observation on that day is it your opinion that these results were inferior or superior to the Standard Minerals Separation practice metallurgically?

A. They were inferior.

Q. 23. How would you explain the fact that any metallurgical result at all was obtained in that process on that day with the amount of oil that was used?

A. First, by the absorption of oil by the vast amount of gangue slime returned into the circuit and second by the fact that when you consider the large proportion of the oil to have been absolutely useless to obtain any effect, either good or bad, in flotation. A portion of the oil was of a nature that caused it to congeal on being added to water of the ordinary temperature, that I think being the paraffin portion of the mineral oil which to my mind would make it

Ira L. Greininger.

useless in the matter of oiling mineral, and I do not think it would have any harmful effect. It would be rather neutral.

Q. 24. Has it been your experience that oil congealed in that way is useless for the purpose of flotation?

A. I can only base my answer on the appearance of this material in the water and after having solidified as it does, I don't consider that it could be of any use.

Q. 25. You took a series of samples on that day, I understand?

A. We did.

Q. 26. Or rather a series of samples were taken?

A. Yes.

Q. 27. You haven't yourself personally analyzed any of them?

A. I have not.

Q. 28. That has been for others to do?

A. They have been analyzed by others.

Q. 29. Did you have to do personally with the taking of those samples?

A. Of a number of them, yes.

Q. 30. And what was done with those samples?

A. Duplicate samples were taken to be retained by each side and they were sealed—at least those retained by the Minerals Separation staff were sealed at the plant under the inspection of the Butte & Superior gentlemen and they were transported to the

Minerals Separation laboratory in the city of Butte where they have since been in the custody of Dr. McIlhiney.

Q. 31. Do you recall what samples were taken or what samples were taken of?

A. Samples were taken of the new feed as it left the grinding mill, of the oil then being added, of the various other reagents including sulphuric acid and the copper sulphate in solution, the feed to the plant after having passed through the elevator at which time it had been combined with the return middlings. Then there were samples of the rougher concentrates from machines 5 and 6, I think, the pyramid machines—yes, pyramid machines 5 and 6, also the middlings from these same machines and general concentrate and general tails samples. There might have been others that I overlooked but that is all I can recall now. There were other samples. There was a sample of original ore taken at the shaft before going into the crushing plant, and a sample of the crushed ore taken at the tripper just above the fine ore bin, also a sample of the underflow from several Dorr thickeners which were handling the overflow from various machines in the wet concentrat~~e~~ion section, the underflow from these Dorr thickeners also having been merged with the other flotation feed.

Q. 32. Have you had experience in the absorption of oil by ~~clear~~ clay gangue slimes? Do you know that oil is absorbed?

Ira L. Greininger.

A. I know by tests that the oil is absorbed by that particular gangue slime and I have seen the same phenomena in other places to an extent, but as I never tried anything on as extensive a scale as this was tried I have no other parallel experience.

Q. 33. But you have known of this phenomena in other places?

A. I have known of it in a general way, yes.

Q. 34. Where was the oil fed into the system that day?

A. At the discharge of the tube mill which is designated by the officials at the mill as No. 1 in section No. 2, at the discharge of that mill.

Q. 35. Was the oil in the feed tanks warmed or heated, did it have the appearance of warmed or heated oil?

A. I think it was heated to an extent. I did not test the degree of heat.

Q. 36. Was the water of the pulp circulating through the system warm or cold?

A. I think it was about at the temperature of the atmosphere at that time.

Q. 37. You observed that the oil used on that day contained a considerable proportion of Jones fuel oil. What sort of oil is that?

A. It is a mineral oil.

Q. 38. As to whether it is a paraffin or a waxy base?

A. It is a paraffin base oil.

Ira L. Greininger.

Q. 39. It is?

A. Yes.

Q. 40. And how does it behave in cold water?

A. The portion which I take to be the paraffin portion seems to coagulate and form a wax like material.

Q. 41. Forms a semi solid substance?

A. It does, yes.

Q. 42. It does not flow?

A. No, not after being added to the water. It seems to coagulate and seems to be in a sort of semi-solid state.

Q. 43. From your experience would you consider that oil in that state or condition would be useful in flotation?

A. I would not.

Q. 44. Would you consider it to be harmful in flotation?

A. I do not see that it could be harmful. I don't understand what harm it could do.

Q. 45. You were one of the parties, were you, who on behalf of the plaintiff visited the Magna flotation plant of the Utah Copper Company on April 21, 1917?

A. I was.

Q. 46. And you inspected that plant which was operating on that day?

A. I did.

Q. 47. Between what hours?

Ira L. Greininger.

A. From about twelve o'clock noon until seven P. M. in the evening of that day.

Q. 48. Will you please briefly describe the process that you saw in operation?

A. They were at that time treating by flotation a product known as their vanner concentrate. This material was classified and a portion of the underflow and the overflow from these classifiers was sent to Dorr thickeners where it was thickened, the underflow from the thickener going to a sludge tank and thence to an emulsifier at the head of the flotation machine proper and the overflow from these Dorr thickeners was sent back to the mill circuit. The machine consisted of two emulsifiers, Janney machines without spitzkastens, followed by as I remember it 17 Janney cells, double spitzkasten.

MR. KENYON: At this time I offer this flow sheet in evidence as plaintiff's exhibit.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 245.

MR. KENYON: Q. What is the flow sheet I now show you?

A. It is a flow sheet of the Magna plant.

Q. 49. Flotation plant at the Magna plant of the Utah Copper Company?

A. Yes.

Q. 50. Please comprehensively describe the process from this flow sheet as you saw it that day?

Ira L. Greininger.

A. This sheet commences with the Dorr tank. That is as marked "Dorr tank" on this exhibit. The flow from that is to the sludge tank, which is so marked. From the sludge tank the flow passes to two emulsifiers and from the emulsifiers to the feed end of the flotation machine proper. At the time of our visit concentrate was being produced on the first six cells, that is the double spitzkasten of the first six machines, finished concentrate—while a middling was being produced on the remainder of the machines in series, these middlings being returned to the sludge tank. Oil was added after having left the sludge tank, also at the same point, what is described as Calura. The first spitzkasten produced concentrate intermittently. The concentrate in the first spitzkasten, or the float in the first spitzkasten was very oily, largely an oil emulsion. In separating it on vanner or batea, it was easily divided into two separate and distinct products, one being an oily emulsion containing little or no mineral and globules of oil, the other product being the mineral froth.

Q. 51. You say it could be separated?

A. It could be separated.

Q. 52. How?

A. By shaking in an ordinary pan or batea. This froth on analysis contained 26.1% oil, and while it

P. 4335, L. 17, after " arrival " insert " at the plant before lunch. After that it only overflowed "

Ira L. Greininger.

A. Of the solids contained in that same froth. The next spitzkasten produced a froth which had less the effect of an emulsion, although it was still quite oily, and the concentrate produced by that spitzkasten carried just under 5% of oil of the solids contained; to be accurate I think it was 4.81%.

Q. 54. Going back to the figure 26.1 per cent of oil, what was it that showed that percentage of oil?

A. The concentrate; the sample taken of this particular froth.

Q. 55. You said of spitzkasten No. 1?

A. Yes.

Q. 56. The total overflow of spitzkasten No. 1?

A. At the time the sample was taken it was not overflowing. The spitzkasten was overflowing on our arrival intermittently, and at the particular time that this sample was taken, it was dipped from the froth on the surface of the spitzkasten, if I am not mistaken.

Q. 57. But it was the total float on the surface of the first spitzkasten?

A. Of the surface of the first spitzkasten at the time the sample was taken.

Q. 58. And this that showed 4.81% of oil, what was that?

A. It had more the appearance of a true froth.

Q. 59. What was it that showed that much oil?

Ira L. Greininger.

A. Spitzkasten No. 2. The ~~only~~ way that sample was taken, it amounted to a cut of the entire product of it for a very brief period of time.

Q. 61. Was it the total overflow of spitzkasten No. 2 which showed that second proportion of oil?

A. 4.81 per cent, yes. Proceeding from there down toward the middling part of the machine, the concentrate assumed a more normal aspect, and the largest amount being delivered by any spitzkasten was reached at the fourth machine.

Q. 62. Spitzkasten No. 4?

A. Spitzkasten No. 4.

Q. 63. Please enlarge a little on that.

A. This froth had assumed a normal aspect.

Q. 64. What do you mean by normal?

A. It had lost this extremely over-oiled condition; while there was still evidence of over oiling, it was not the extreme over oiling which one noticed on the first and second spitzkasten.

Q. 65. The more normal froth, the mineral froth that you had been accustomed to see in the flotation process?

A. Approaching very closely to it.

Q. 66. What was it on No. 4?

A. The maximum was produced, was obtained by spitzkasten No. 4. No. 5 and No. 6 were about the same amount; that amount, of course, as far as I know, has not been accurately weighed; anyway I have not the figures.

Ira L. Greininger.

Q. 67. About the same amount, was it, in spitzkasten 5 and 6?

A. I think it was slightly less on those.

Q. 68. As compared with No. 4?

A. It didn't exhibit such evidence of over oiling as I proceeded towards the middling end of the machine. From spitzkasten No. 6 the product from the rest of the spitzkasten was all returned as middlings, from 7 to 17 inclusive.

Q. 69. And what was the character of the froth overflowing from spitzkasten No. 7, for example?

A. Here we again have the oil getting low, although with a high level of the water in the spitzkasten, which brings up the material, and the material had the appearance of froth. The froth was rather light and watery in appearance, while it contained some mineral, not the marked amount which accumulated on the other spitzkasten, due to the fact that on the concentrate spitzkasten the froth is removed mechanically, and the level is maintained somewhat below the lip of the spitzkasten.

Q. 70. On spitzkasten 1 to 6 where was the level of the water maintained?

A. Somewhat below the level of the lip of the spitzkasten, as the froth extended some inches below the top of the spitzkasten, and was raked off by mechanical paddles, or the like.

Q. 71. Spitzkasten 1 to 6 had mechanical means for raking off the froth into the launder?

Ira L. Greininger.

A. Yes, and for the middlings it was allowed to run over more freely.

Q. 72. No. 7 to 17, did they have mechanical means of scraping off the froth?

A. I am not clear as to that now; I think perhaps they were provided with such a device, but they were less useful, for the level was maintained higher, and more water was passing over, and consequently there was no great occasion for raking off the froth.

Q. 73. How about the amount of water overflowing from spitzkasten 7 to 17?

A. There was no great amount of water. The levels were practically close to the top of the spitzkasten; not a vast amount of any material.

Q. 74. A thin sheet of water?

A. A thin sheet of watery froth; I could not say there was any clear water coming over but a thin sheet of watery froth passing over.

Q. 75. What was the appearance of the average overflow from spitzkasten No. 7 as to over oiling?

A. There were patches of what appeared to be either free oil or vastly over-oiled mineral; very small amounts of course. At different points on these spitzkasten from the 7 down to the 10, part of the surface would be white watery looking froth, while other parts would be carrying mineral, which appeared to be vastly over oiled, or almost an oil emulsion.

Q. 76. What patches of those?

A. Patches of these would accumulate. The amount

Ira L. Greininger.

so produced could not be large, but there was such an appearance on those spitzkasten.

Q. 77. This watery froth that you have described as overflowing in spitzkasten 7 to 17 was a normal middling froth or middling concentrate?

A. Well, it was rather excessive, based on my past experience.

Q. 78. Excessive in what direction?

A. In the number of machines sending middlings back, and the amount of middlings being passed from them.

Q. 79. That was large?

A. It was large compared to what I have seen in my experience, and what I have done.

Q. 80. And the character of the froth as compared with the middling concentrate that you are familiar with in standard practice?

A. Barring those patchy appearances of over oiled material, it was very much the same as one would get in running the middling off rather rapidly, and not giving it a chance to accumulate on the spitzkasten.

Q. 81. These descriptive legends on the flow sheets, are they all accurate descriptions of the parts to which they relate?

A. According to my memory they are all correct. There was one mistake here in the overflow from the Dorr thickener, which was marked "to waste" which I see here has been corrected and marked "to circuit."

Ira L. Greininger.

Q. 82. Have you any other comments to make on what you observed that day as to this process?

A. I think not.

Q. 83. What is your opinion as one practically experienced in the standard practice of the plaintiff as to the substantial identity or non-identity of this process that you saw on April 21st at this mill with the standard Minerals Separation process? Is it the same process or a different process?

A. I consider it the same process.

Q. 84. Would you regard it as as good flotation metallurgically as the standard Minerals Separation practice with which you are familiar?

A. I would not.

Q. 85. Why?

A. On account of the vast amount of oil that was being used, and its ill effect on the handling of the concentrate, as well as its excessive cost.

Q. 86. How do you account for the fact that any metallurgical result at all was obtained with the quantity of oil there used?

A. There was a factor entering into this work with which I am not familiar. I do not know what its effect would be; I never have used it in any way and never have tested it.

Q. 87. What is that?

A. That is the addition of this so-called calura and as to what it is for or what its effect was, I could not say. I have not made any experiments with that material.

Ira L. Greininger.

Q. 88. You have had no experience with it?

A. I have not.

Q. 89. In practical flotation processes?

A. Not with this particular material, no.

Q. 90. I presume you were informed what oils they were using there?

A. Yes, we were told as to what the mixture was.

Q. 91. Do you recall what you were told?

A. As I remember it we were told that the oil was made up of 50% Jones oil, which has been referred to in this trial heretofore, 37½%, as I remember, of a particular fuel oil which has a definite name; I have it in my notes there, but I have forgotten what it is.

Q. 92. Do you want to look at your notes?

A. If you please. 37½% Lyoth fuel; 12% American creosote and one-half of one per cent pine oil.

Q. 93. Was this Jones oil the same that you have spoken of in connection with the Butte & Superior operation?

A. I understand it to be.

Q. 94. Did you take samples and specimens that day?

A. We did.

Q. 95. State where you took them.

A. We took samples of the mill circuit water, the overflow from the Dorr thickener, the new feed to the flotation plant, and of that was also taken a time or tonnage sample; a sample of the circulating mid-

dling, and also a tonnage sample of that product; samples of the oil, and a time sample of the oil; samples of the calura, so-called, and a sample of the concentrate from the general concentrate after the product from the various spitzkasten had been intermingled, and several samples from spitzkasten 1, 2, 3, 4, 5, and 6, those producing the finished concentrate, and two other samples from spitzkasten No. 10, producing middlings, and a sample of the general tails; I think that covers the list.

Q. 96. What did you do with those samples?

A. Those samples were kept in our personal possession until we returned to Butte, when they were delivered to the laboratory of Minerals Separation corporation, and since then they have been in the custody of Dr. McIlhiney.

Q. 97. Have you ever, in all your experience in flotation, considered or figured or taken into account the oil that is theoretically being returned with the middlings to the head of the machine as a part of the oil supply of the machine?

A. I never have.

Q. 98. Why not?

A. I never considered it as an element influencing extraction one way or the other. If I have had a middling containing some oil, which I suppose it did —I have made extensive experiments to determine whether or not the returning of the middling affected extraction; that is, being returned to the same machine in which the middling was produced. I have ex-

Ira L. Greininger.

perimented with that matter by returning the product of from one spitzkasten up to seven out of eight, and I could detect no difference whatever as to extraction; there was no difference caused by these changes. Having made those tests and determined that, I have disregarded it as an element controlling or governing extraction. I have made the return of the middling only for the purpose of bringing the grade of the total product produced up to a given figure or up to the highest figure possible in a given plant.

Q. 99. You never regarded it as an oil-saving operation to return middlings to the head of the same machine?

A. I never have looked upon it from that light or considered it from that standpoint.

Q. 100. Have you ever observed or found that less oil need be fed—less new oil—to a machine in which middlings are returned to the head of the same machine?

A. Not in my experience.

Q. 101. Then what has your experience led you to conclude as to that?

A. That the oil contained in such middling, if oil there was, had no effect whatever one way or the other as far as regards extraction.

MR. KENYON: The witness is yours.

Ira L. Greininger.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 102. I think you said that the concentrate of No. 1 machine at Magna contained 26% of oil?

A. 26.1.

X-Q. 103. Did you say that that concentrate was produced by the process of the patent here in suit; do you remember whether you did or not?

A. I don't think I referred to that particular spitzkasten.

X-Q. 104. Let us refer to it now.

A. I considered it was the entire operation which was an operation of the patent in suit.

X-Q. 105. Of that first unit?

A. The operation taken together.

X-Q. 106. The first cell; did you say the first cell?

A. Not taken distinctly and individually, no.

X-Q. 107. Well, I understood that this concentrate containing 26.1% of oil came off from the first cell?

A. It did, yes.

X-Q. 108. And my question was whether that operation in that first cell was the practice of the process of the patent in suit.

A. If the action had stopped at that point, I would not consider it so, no.

X-Q. 109. So you don't think that the process of the patent in suit was practised in that first cell?

MR. WILLIAMS: I object to that. Are you going to ask the witness for a legal opinion?

MR. SCOTT: He was asked whether the process used there was not the process of the patent in suit and of the Butte & Superior.

MR. WILLIAMS: The mere fact that he happened to use that name—

MR. SCOTT: He used the name seriously.

MR. WILLIAMS: The mere fact that he happened to use the name when he named the process is no reason for cross examining him as to the patent in suit.

THE COURT: I don't understand why. He testified explicitly that in his judgment this was the plaintiff's process, except that it was practised using an excess of oil. The objection will be overruled.

Plaintiff excepted.

X-Q. 110. (Last question read as follows: Q. So you don't think that the process of the patent in suit was practised in that first cell?")

A. If the process had ceased at that point, I would not consider it the process of the patent in suit.

X-Q. 111. You mean what went on in that particular cell was not the process of the patent in suit?

A. I would not look upon it as such.

X-Q. 112. Well, what were the distinguishing features of this froth in this first cell that leads you to that conclusion?

A. This oil emulsion which was present in the cell.

X-Q. 113. What oil emulsion?

A. Well, I have heretofore described it on direct examination.

X-Q. 114. Describe what the difference is between it and something else, which comes under the patent in suit?

A. It was an agglomeration of oil globules, with little or no mineral; the operation did not separate out the mineral or form a froth.

X-Q. 115. Were there any bubbles in it?

A. There were oil globules; no bubbles that I could distinguish.

X-Q. 116. No air at all?

A. There might have been some entrapped air, yes.

X-Q. 117. Did you look to see?

A. I examined it carefully, and no doubt I saw some entrapped air in this emulsion.

X-Q. 118. What is entrapped air; did you see any air bubbles?

A. I can not definitely recollect having seen a particular air bubble in the froth, at the present time.

X-Q. 119. Can't you remember what you saw, a week ago?

A. I say I can not remember having seen air bubbles in the froth.

X-Q. 120. Have you seen them, and do you think you have forgotten it, or are you in doubt whether you saw them at all or not? Those are two different things, to forget a thing and not to know it.

Ira L. Greininger.

A. As I remember there were globules of oil; but as to whether or not there was air, I can not positively say.

X-Q. 121. Then you are prepared to say this was or was not the process of the patent in suit without knowing anything about whether there was any air there or not? Is that the idea? You say you are not sure about the air and yet you are giving us a positive statement as to whether it was the process of the patent in suit or not. It doesn't make any difference about air? Is that the idea?

A. This particular froth as I said was made up of such material that it did not resemble until it was divided any froth that I have seen produced anywhere.

X-Q. 122. What is a froth?

A. What is a froth?

X-Q. 123. Yes.

A. We understand it as being made up of air and mineral and a small amount of oil.

X-Q. 124. This was a froth that you saw but wasn't your particular froth. Well, what was the difference?

A. The vast amount of oil present was the greatest difference.

X-Q. 125. The amount of oil?

A. Yes.

X-Q. 126. How about cell No. 2?

A. Cell No. 2 was approaching the normal froth.

X-Q. 127. Had it got there?

A. I think it had.

X-Q. 128. You do?

A. I do.

X-Q. 129. And you said that that concentrate had in it 4.81 per cent of oil, didn't you?

A. It had.

X-Q. 130. How about the other cells? Was there a No. 3? I didn't hear anything about that?

A. No. 3 carried less oil than No. 2.

X-Q. 131. Carried less oil?

A. Yes.

X-Q. 132. That you consider was a real froth?

A. I certainly do.

X-Q. 133. Or some other kind of a froth?

A. I consider it a real froth.

X-Q. 134. Well now, referring to what you saw at the Butte & Superior Company on the 29th of April, I notice according to this report in evidence the rougher concentrate from the first spitz box went to the cleaner cell carrying 2.77 per cent of oil and was cleaned in the cleaner. Was that the process of the patent in suit?

A. I consider it so, yes.

X-Q. 135. It was?

A. Yes.

X-Q. 136. Well, now, that material carried over forty pounds of oil and was cleaned with that amount of oil, forty pounds per ton, that was practicing the process of the patent in suit, was it?

Ira L. Greininger.

A. I consider the operation in the Butte & Superior plant on that day the practice of the patent in suit.

X-Q. 137. What is that?

A. I said that I considered the operation in the Butte & Superior plant that day—

X-Q. 138. You consider they are the patent in suit no matter how much oil there was anywhere, is that the idea?

A. It depends somewhat on circumstances.

X-Q. 139. If there is no exception to it we might as well clear that up and stop asking questions about it. Did you see anything at all there that you did not consider the process of the patent in suit?

A. I did not.

X-Q. 140. You did not agree with Dr. Grosvenor in his statement that solid grease will function in this flotation plant either magnificently or maliciously, do you?

A. I don't know whether Dr. Grosvenor made such a statement.

X-Q. 141. Well, do you believe that solid grease will not function either to advantage or disadvantage?

A. It would depend on the particular circumstances and what particular grease was refererd to.

X-Q. 142. Well, the mere fact of its being solid you don't think would remove it from the sphere of action, do you?

A. After having experimented with it, I consider that it will.

X-Q. 143. That it will remove it from the sphere of action?

A. Yes.

X-Q. 144. That is what I understood you to say. What was it that you say oiled—did you say absorbed by gangue slime?

A. I think I said so, yes.

X-Q. 145. Where was it you saw that besides what you say you saw at the Butte & Superior?

A. At the Inspiration property, principally.

X-Q. 146. Do you know anything about the relation of fine material in the middlings that were returned to the Butte & Superior, to the proportion of fine material in the original feed?

A. Only by observing the conditions where they were visible and knowing that the fines will go over in all conditions where a large overflow of water is maintained.

X-Q. 147. You just guessed at that, didn't you?

A. I think it is somewhat more than a guess.

X-Q. 148. You feel pretty sure of it, do you?

A. I feel absolutely sure of it.

X-Q. 149. You think you are a pretty good judge of that sort of thing just by looking at it?

A. I consider myself so.

X-Q. 150. Where did you learn that there was Jones oil and Jones fuel oil being used at the Butte & Superior the day you were there?

A. It seems to me I heard it stated by Mr. Dosenbach on the witness stand.

Ira L. Greininger.

X-Q. 151. You may have misunderstood him, may you not?

A. There are so many kinds of these Jones products I might have misunderstood him.

X-Q. 152. You are not very certain about it are you?

A. Well, naturally my information is from other parties; I didn't put the oil in myself.

X-Q. 153. What temperature will the solid matter coagulate out of the Jones fuel oil?

A. I have seen it coagulate at the atmospheric temperature in experimental work.

X-Q. 154. Well, what atmospheric temperature? In New Zealand or Greenland?

A. In the city of Butte within the last ten days.

X-Q. 155. Summer or winter?

A. Within the last ten days.

X-Q. 156. You don't know what the temperature was on that day?

A. I didn't take the temperature on that particular day, no.

X-Q. 157. How much of it coagulated out?

A. A considerable amount, after having been violently agitated.

X-Q. 158. Well, don't you know any more definite than that, "considerable amount"?

A. No, I don't know the exact proportion of oil that coagulated out.

X-Q. 159. A little bit of cyanide of potassium would

be a considerable amount in a tumbler of water. I can't get any idea from you how much.

A. It amounts approximately to 20 or 25% of the total.

X-Q. 160. 20 to 25%?

A. Of the total, yes.

X-Q. 161. Did you try this experiment of the coagulating part of this Jones fuel oil by using the Jones fuel oil alone or in mixture with other oils?

A. I think it was tried both ways.

X-Q. 162. You think it was?

A. Yes.

X-Q. 163. What other oils did you mix it with?

A. The mixed oils used by the Butte & Superior at that time.

X-Q. 164. When did you do that?

A. It was done on various days.

X-Q. 165. Did you do it yourself?

A. I was present when it was done.

X-Q. 166. Did you get a sample of this froth at the Magna plant while it was overflowing?

A. No.

X-Q. 167. You took some that had been accumulated there for a period, but you don't know how long it was?

A. Yes, at the time it was taken the spitzkasten was not overflowing. How long it had not been I am not prepared to say.

X-Q. 168. How much oil was being used per ton

Ira L. Greininger.

on this Sunday when you were at the Butte & Superior mill?

A. The figures given by—

X-Q. 169. (Interrupting.) The figures given?

A. —by Mr. Shimmin are about 26 pounds.

X-Q. 170. 26 pounds?

A. Yes.

X-Q. 171. And how much oil was being used per ton at the Magna the day you were there?

A. The relation of new oil to new feed amounted to 21.82, as I understand.

X-Q. 172. 21.82?

A. 21.82 pounds per ton based on figures made up from our samples.

X-Q. 173. And you do not think that the oil coming back with the middlings played any part in the operation?

A. I feel absolutely sure it played no part whatever.

X-Q. 174. You feel sure it didn't?

A. Yes.

X-Q. 175. Now, do I understand you right: You say you saw the operation at the Magna plant with ~~which~~ I think you said, 21 lbs. of oil per ton, and you saw an operation at the Butte & Superior with 26 lbs. of oil per ton. You say that the operation in the first spitz at the Butte & Superior plant was the process of the patent in suit, but that the operation in the first spitz in the Magna plant with the lesser amount

of oil was not the process of the patent in suit. Was that what you said?

A. I said if the operation had stopped at that point—considering that independent and by itself—

X-Q. 176. (Interrupting.) Well, it didn't stop at that point. I am asking you the way it happened.

A. I answered concerning the whole operation as one, and considering it as stopped at that point.

X-Q. 177. Well, maybe I am hard of understanding, but I don't get the point. Both of these plants were operated with the pulp running from this first cell down through the others, weren't they?

A. They were.

X-Q. 178. And neither of them were stopped at that point, were they?

A. No.

X-Q. 179. Then why don't we cut that out? Why is it that the Butte & Superior operating with 5 pounds more oil than the Magna, is practising a process of the patent in suit and the Magna is not? I want to get your distinction.

A. I think my answer concerning the entire operation covers that point.

X-Q. 180. Well, explain it if it does; I would like to know it. I can't understand it; I can't see what that has got to do with it.

MR. WILLIAMS: I object to this mis-statement by counsel for the defendant as to the testimony of the witness, which it seems to me should not be permitted.

Ira L. Greininger.

MR. SCOTT: If you will point it out I will correct it.

THE COURT: Well, I think perhaps you place an interpretation upon his language that he did not intend; you may repeat the question if you will.

X-Q. 181. MR. SCOTT: I want your explanation of why it is that the Butte & Superior using 26 and a fraction pounds of oil per ton practises the process of the patent in suit in the first cell of the series, where all of that oil enters with the feed, and at the Magna, where they use 21 lbs., about 5 pounds less, the process in that first cell, where the oil all enters with the feed, is not the process of the patent in suit.

A. They don't get the results of the patent in suit?

X-Q. 182. Now, I will have to have you define the result again.

A. That is mineral froth.

X-Q. 183. It doesn't depend on the quantity of oil, then, whether—The determination of whether you are practising the process of the patent or not, it is the result that determines it? Is that the idea, irrespective of the amount of oil?

MR. WILLIAMS: I object to that because it seems to me that counsel for the defendant is continually infringing upon the question of construction. Here is a witness who goes on the stand and tells the appearance of certain operations and now he is asked whether the process of the patent in suit depends upon the amount of oil. I submit that there is

nothing in the testimony of this witness that warrants the putting of such a question to him.

MR. SCOTT: The witness your honor, seems to distinguish between the one and the other and I think I am entitled to find out how he does it.

THE COURT: Well, the question might be whether he is judging from his expert knowledge or the occurrence as he saw them. I don't think that is made clear. He was asked the direct question whether this, as he saw it, was substantially the process of the patent in suit in both cases, in both mills, and he answered yes.

MR. KENYON: I asked him only to compare a standard Minerals Separation process as he knew it, with what he had seen. I did not bring in the patent in suit or any question of construction of the patent in suit, just a comparison of two processes, which is a proper question to ask an expert.

THE COURT: Well, if you asked him if it was the patent process you unquestionably also asked him if it was the process of the patent in suit. There is no doubt of that because the patent process is the process of the patent in suit. Well, you will have it written out tonight, and we will see when we start in the morning.

Whereupon an adjournment was taken until tomorrow, May 10th, at 10 o'clock a. m.

Ira L. Greininger.

Thursday, May 10, 1917, 10 a. m.

MR. SCOTT: I have no further cross examination.

RE-DIRECT EXAMINATION.

BY MR. WILLIAMS:

R-Q. 184. In your testimony counsel named the fuel oil that was used at the Butte & Superior at the time you inspected the plant as Jones fuel oil, and in some of the questions and answers that name persisted. Now, what I want to know is whether your testimony in regard to that fuel oil was irrespective of whether it was Jones oil or not.

A. It was based on my memory of what I considered was testified to, but on looking up the record I find that the oil used that day was designated as fuel oil, and Jones was not attached.

R-Q. 185. When you were testifying about that oil there as a fuel oil, or as Jones fuel oil, to what oil were you referring in your testimony?

A. I was referring to a fuel oil.

R-Q. 186. Were you or were you not referring to the fuel oil that you found in those products?

A. In the mixture used at the Butte & Superior plant on the day on which the inspection was made.

R-Q. 187. And what you said about the characteristics of fuel oil, referred to that particular fuel oil?

A. To that particular fuel oil used on that particular day.

R-Q. 188. That was the fuel oil that you examined, was it?

A. It was.

R-Q. 189. Now, what has been your experience in the use of fuel oils and petroleum oils generally in the froth flotation process of Minerals Separation Limited?

A. I have never been able to make any use of them —I will say any beneficial use—as regards the extraction of minerals—of any mineral oils which I have tried. I have used them for other purposes, but I did not consider them at the time as being useful in the extraction of mineral.

R-Q. 190. For what purpose have you used them?

A. I have used stove oil for the purpose of thinning thick tar product so it would be easily fed through a small opening.

R-Q. 191. In what proportions have you used that, small or large?

A. This amounted to about 75% of the total oil used being the amount necessary to thin the tar to such an extent that it would pass through a small opening at the rate I required.

R-Q. 192. And now, as the result of your experience, how would you characterize those oils in the froth flotation process, as active or inactive?

A. In my experience, in all cases where I have tried them, they have been to my knowledge inactive, and I would so characterize them.

R-Q. 193. Where you have used them, have you used them alone, or in mixtures?

A. I never have used them or attempted to use them alone—I will qualify that; I attempted to use stove oil and fuel oil alone—that is, a combination of the two, but failed to get any metallurgical results.

R-Q. 194. Whenever you used these in active oils, was there or was there not a soluble frothing agent present?

A. There was.

R-Q. 195. Now in the operations at the Butte & Superior and at the Utah Copper Company, Magna plant, that you inspected, how did the agitation compare with that of standard Minerals Separation practice?

A. Very much more violent.

R-Q. 196. In the operation as carried on in the Butte & Superior—I don't know whether you have testified to it or not, but it has appeared in the record that a material generally described as sulphate of copper was used in solution; do you remember that?

A. I do.

R-Q. 197. And you mentioned the fact that Calura was used at the Utah Copper Company?

A. I did.

R-Q. 198. Tell me whether or not these reagents are used in large proportions as compared with the use of any reagents other than sulphuric acid, we will say, in standard Minerals Separation practice?

A. The amount of Calura used at the Utah Copper plant I consider to be very large. The amount of sul-

phate of copper at the Butte & Superior has been testified to in this trial, and as to the amount of solution it was very much greater than I would consider using of anything, other than sulphuric acid.

R-Q. 199. In the report of your testimony yesterday, in answer to question 4, have you any correction to make to the evidence as reported?

A. That seems to be correct.

RE-CROSS EXAMINATION.

BY MR. SCOTT:

R X-Q. 200. Mr. Greninger, have you ever used what you call the inert fuel oil together with a soluble frothing agent?

A. I have experimented with them at times.

R X-Q. 201. Ever used them in a plant?

A. In a commercial plant yes.

R X-Q. 202. And what was your object of combining the fuel oil with the soluble frothing agent?

A. I was attempting to improve the extraction.

R X-Q. 203. What kind of an extraction did you get?

A. I got no change from what I was getting with the use of the soluble reagent.

R X-Q. 204. When you used what you call the inert fuel oil, using 75 per cent of the fuel oil and 25 per cent of the tar—is that right?

A. Yes.

R X-Q. 205. How much oil did you use per ton of ore?

Ira L. Greininger.

A. In the vicinity of two pounds per ton.

X-Q. 206. Of that mixture?

A. Of the mixture. I would say approximately two pounds to the ton.

X-Q. 207. On that same ore did you ever use a soluble frothing agent alone, that is by "soluble" I mean like creosote or such thing?

A. I attempted to use the tar alone, a portion of which was soluble, but I wouldn't attempt to say what, but on account of the viscous nature of the oil I was unable to feed it regularly and had to discontinue using the same.

X-Q. 208. Did you ever use any other soluble or partially soluble oil in that ore?

A. I used various wood tar oils from different timber, but they were all of the same character and nature.

X-Q. 209. How much per ton did you use on this same ore of the wood tar oils?

A. That is very hard to determine on account of as I say the difficulty in handling the thick viscous product through a spigot, which was the only way of feeding it at that plant.

X-Q. 210. Well, you know how much you used, don't you, per ton, of these wood tar oils?

A. Well, the experiments were very short and as soon as I was convinced I couldn't feed it with regularity I ceased to use them as I was working for commercial results.

William Nichols Rossberg.

X-Q. 211. What is your judgment as to the quantity of the wood tar oils you used per ton of ore?

A. I considered at the time that I could have gotten the results with approximately the amount that I used in solution of the mineral oils, if I could have gotten the tar to the point where I could have fed it at that rate.

X-Q. 212. But you never verified that conclusion?

A. No.

X-Q. 213. By measurement?

A. Not strictly speaking.

MR. SCOTT: That will be all.

WITNESS EXCUSED.

WILLIAM NICHOLS ROSSBERG, called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. KENYON:

Q. 1. What is your name, age, residence and occupation?

A. William Nichols Rossberg; I am 35 years old; I am engaged as metallurgical engineer for the Clark interests.

Q. 2. Residence?

A. Butte.

Q. 3. And your present specific employment?

William Nichols Rossberg.

A. Superintendent of the Timber Butte mill.

Q. 4. Will you state briefly your education and experience in metallurgical lines, practical metallurgical lines?

A. I took the degree of mining engineer at Columbia University in 1904. I was first engaged on mill construction work in 1904 and have been engaged continuously ~~continually~~ since that time in mining work and milling, mill testing and metallurgical work. In 1912 I came to Butte as metallurgical engineer for the Clark interests and did the testing for the treatment of the Elm Orlu ore. In 1914 when the Timber Butte mill was started I took charge of the Timber Butte mill and have been superintendent up to the present time.

Q. 5. What work is done at the Timber Butte mill?

A. At the Timber Butte mill we are now treating the Elm Orlu zinc ore in our zinc mill and the copper tailings from the reduction works—from the old reduction works of the Colusa-Parrot Reduction plant.

Q. 6. Will you please give a description of the zinc concentrator plant at the Timber Butte mill, producing a flow sheet for that purpose?

MR. KREMER: At this time defendant wishes to interpose the same objection to this testimony, that it is incompetent, irrelevant and immaterial, not tending to prove any issue in the case; and if to prove utility it serves no purpose in the case. This is the same objection as made to the previous testimony of this character.

THE COURT: I think it probably bears on the question of extensive use. The objection will be overruled.

Defendant excepted.

MR. KREMER: This may all go in under the same objection?

THE COURT: Yes.

Q. 7. You have a flow sheet, have you, of the zinc concentrator at the Timber Butte mill?

A. Yes, sir.

MR. KENYON: At this time plaintiff's counsel offers in evidence the flow sheet produced by the witness.

Flow sheet admitted marked PLAINTIFF'S EXHIBIT No. 246.

Q. 8. Please now describe that plant from the flow sheet.

A. I might explain first that there are really only five main operations in the mill, although the flow sheet shows practically every machine in operation, The flow sheet, briefly, consists of two roughing table operations followed by flotation work. The flotation work is conducted in three stages; first the rougher operation.

Q. 9. Indicated by what numeral?

A. No. 42 on the flow sheet, near the bottom of the flow sheet. This is the rougher machine, and No. 44 is an intermediate machine, and No. 46 is our recleaner flotation machine. The intermediate and

William Nichols Rossberg.

the re-cleaners serve to clean the rough concentrate from the rougher flotation machine.

Q. 10. Now, just comprehensively describe the whole operation, but without detail.

A. The feed is first crushed in the coarse grinding plant, and later in rolls to 10 mesh size.

Q. 11. Indicate by numerals where those crushers and rolls are as you go.

A. The first crusher is No. 4; that is a Farrell crusher; it is simply a coarse crusher. From the coarse crusher the ore is sent to a Symons crusher, which is No. 7. The ore is reduced to three-quarter inch size in the Symons breaker, and from there it is fed, over No. 8, to the secondary ore bins, or No. 9 on the flow sheet. From No. 9 the ore is conveyed to two sets of rolls, which are No. 13, and from the rolls the ore is elevated to eight impact screens, No. 15, and the undersize from the impact screens is sent to eight Wilfley roughing tables, No. 18. The Wilfley roughing tables produce a finished zinc concentrate, which is sent to our coarse concentrate bins, No. 61, at the bottom of the flow sheet. The Wilfley roughers also produce a lead-copper-iron-zinc middling, which is sent to our lead section.

Q. 12. That lead section being indicated generally by what numbers?

A. The lead section is found to the left of the flow sheet, and the elevator which supplies the lead section is No. 28. The lead section simply serves

to separate out the small proportion of lead and a little copper-iron concentrate from the zinc.

Q. 13. That is delivered where, to what bin?

A. The zinc of the lead section goes to the coarse bin, No. 61. The lead is sent to the lead bin, No. 62, and the copper-iron concentrate is sent to No. 63, and from the bins the concentrates are loaded into cars and shipped. The tailing from the Wilfley roughers is simply dewatered, or rather de-slimed, by six Akins classifiers, shown as No. 19. The overflow from the de-sliming operation or from the classifiers is sent to a thickening tank shown as No. 39, and the thickened product is sent to the rougher flotation machine. The sand portion from the classifiers is sent to tube mills for regrinding; the two tube mills are shown as Nos. 24 and 23.

Q. 14. You need not go much into detail; just follow it generally through this part of the mill.

A. Well, I was trying to follow the tailings from the Wilfley tables to the tube mills but there is some slight alteration at times, and just which of the two series of grinders those tailings are sent to, I do not remember, but the tailings from the Wilfley roughers are re-ground in tube mills, and are sent to the Wilfley and to the James roughing tables, No. 27. The James roughing tables perform the same operation as the Wilfley roughing tables; in other words, they produce a lead-iron-zinc middling, which is retreated to separate the lead and iron from the zinc.

William Nichols Rossberg.

They also produce a finished zinc concentrate, and a tailing, which tailing is de-slimed, and the coarse portion of the tailing is reground to approximately 65 mesh, and the slime and the reground tailings are both sent to the flotation plant, through the thickener. No. 39, I believe. I should add that the reground James table tailings are sent back over the James table before reaching the flotation plant.

Q. 15. What are the mills 38 and 38-A?

A. 38 and 38-A are used for regrinding the middlings from our finisher tables, and the middlings from our flotation plant; and one of the two mills as a rule takes a portion of the Wilfley table tailings. That is a question of milling details and tonnage as to which of the mills the tailings are sent to.

Q. 16. Now, proceed from the Dorr thickener 39 into the flotation plant, as operated?

A. From Dorr thickener 39 the thickened pulp is sent to—

Q. 17. Thickened to about what dilution?

A. Anywhere from 50 per cent water up to 70 per cent water by weight. The pulp from the Dorr thickener is sent to No. 11 elevator, which is No. 40 in the description and reaches No. 41, which are simply two sludge tanks serving to take up fluctuation in the feed. From No. 41 the pulp is sent to No. 42, the flotation rougher. This is a 14 cell machine, standard Minerals Separation machine which produces a concentrate from the first eight cells and a middling

William Nichols Rossberg.

from the last six cells. The proportion of middlings and concentrate is sometimes varied, but that is the general precedure.

Q. 18. Trace the middlings first from cells 9 to 14 inclusive?

A. The middling from cells 9 to 14 inclusive is sent to No. 49, which is an elevator and thence to two Akins classifiers No. 50. The sand portion from the classifiers or the coarse portion is shown to go to No. 38 and 38-A which are two of the tube mills already referred to.

Q. 19. For regrinding?

A. For regrinding.

Q. 20. And what becomes of the overflow of the classifiers 50?

A. The overflow of the classifiers, which is the fine material or slime, is shown to pass to No. 11 elevator or No. 40 and from there it returns to the flotation rougher for retreatment. The tailings from the flotation rougher are sent to waste. That is our total mill tailings.

Q. 21. Now, take up the concentrate from cells 1 to 8 inclusive of the rougher machine 42?

A. The concentrate from the rougher is sent to No. 43, which is an elevator taking the rougher concentrate to 44, our intermediate flotation machine. The No. 44 machine is an intermediate machine and is a six cell standard size Minerals Separation machine from which we produce concentrate on the first 5 cells, and middlings on the 6th cell and a rich tailing.

William Nichols Rossberg.

Q. 22. Take first the tailing. Where does the tailing from the intermediate machine 44 go?

A. The tailing returns to No. 49 which is an elevator, lifting the tailing up to Akins classifier No. 50 for regrinding in the tube mills No. 38 or 38-A.

Q. 23. Take next the middlings produced in the cell 6 of machine 44?

A. The middling produced in the cell 6 of the intermediate machine simply returns back to the head of the intermediate machine in closed circuit.

Q. 24. To elevator 43?

A. To elevator 43.

Q. 25. Now, take up the course of the concentrate made in the cells 1 to 5 inclusive of machine 44.

A. This concentrate is sent to elevator 45 which elevates the concentrate to cleaner machine 46.

Q. 26. Describe that machine?

A. The cleaner machine produces a finished flotation concentrate on the first 5 cells and a middling on the 6th cell, and a rich tailing, which tailing is returned to the intermediate machine.

Q. 27. To elevator 43?

A. To elevator 43 and the middling is returned back to the head end of the cleaner or the head end of 46 through elevator 45.

Q. 28. That is the middling delivered by cell No. 6 of machine 46?

A. Yes, sir.

Q. 29. Now trace the concentrate produced by cells 1 to 5 inclusive of the cleaner machine 46?

William Nichols Rossberg.

A. The final flotation concentrate from 46 cells 1 to 5 inclusive is sent to No. 47 which is an elevator taking the concentrate to No. 48, a de-sliming Esperanza classifier. The overflow of this classifier is the final flotation concentrate which is shown to go to No. 54 and then to 55, the latter being two Dorr thickening tanks, which thicken the final concentrate for filtering with the Kelly press No. 59. From the Kelly press the filtered concentrate is sent to the fine zinc bin No. 60, and is loaded into cars for shipment to zinc smelters.

Q. 30. What work does the Kelly press No. 59 do?

A. It simply dewaters the concentrate down to approximately ten per cent moisture.

Q. 31. And the spigot product of the Esperanza classifier No. 48, what becomes of that?

A. The sand portion of the classifier, which is the coarsest portion of the flotation zinc, is sent to No. 52, a 5 spigot hydraulic classifier, which sizes the coarse concentrate for treatment over 53, which is 7 James' sand tables. The James machine or tables, No. 53, simply serve to take out a very small portion of lead from the flotation concentrate, and a lead-copper-iron-zinc middling which is also small in quantity and is sent to the jig section through elevator 28. The No. 53 tables also take out a finished zinc which is sent to the Dorr tank No. 55, and to the Kelly press. The tailings or so-called tailings from No. 53 tables

William Nichols Rossberg.

is very rich and is returned to 51, an Akin classifier, from which the sand portion or coarse portion passes through No. 49 and 50 to tube mills 38 and 38-A.

Q. 32. For regrinding?

A. For regrinding. The overflow of No. 51 classifier simply returns back to No. 47 elevator and after the—and over the Esperanza classifier No. 48 and over the tables; and the overflow of the classifiers finally goes into the Kelly press.

Q. 33. Are the various descriptive legends found upon exhibit flow sheet correct descriptions of the parts to which they refer?

A. Yes, sir.

Q. 34. Now, when was this zinc concentrator plant completed and put in operation at the Timber Butte mill?

A. I think the first feed was sent through the mill on June 17, 1914.

Q. 35. And the mill was fully in operation by what time?

A. Well, certainly by June 20th, 1914.

Q. 36. And has remained in operation ever since?

A. Yes, sir.

Q. 37. Will you give us from the records of the company a statement of the amounts and character of oil that has been used in the flotation process in that mill from the beginning to the present time, giving it from month to month?

A. I have the oil record here for August, 1914, up to and including March, 1917.

William Nichols Rossberg.

MR. KENYON: Plaintiff's counsel offers in evidence the record presented by the witness and it is marked plaintiff's exhibit 247.

Record admitted in evidence and marked PLAINTIFF'S EXHIBIT 247.

Q. 38. Now, will you please describe what this oil sheet shows?

A. The oil sheet shows the oil consumption in pounds per ton of original feed and in pounds per ton of flotation feed by months and an average for each year. The August, 1914, consumption is shown to be .6 of one pound per ton of flotation feed. That is the original flotation feed. The average for the year 1914 or rather for the five months—last five months for 1914 is shown to be .66 pounds per ton of original flotation feed.

Q. 39. Per ton of flotation feed?

A. Yes.

Q. 40. Not per ton of original feed—original mill feed?

A. No, sir, it would be less per ton of original mill feed.

Q. 41. That figure also is given?

A. Given as .61 pounds per ton of original mill feed.

Q. 42. The paper that you have produced also gives the acid that was used in connection with the flotation operations, does it not?

A. Yes, sir.

William Nichols Rossberg.

Q. 43. And for the five months of the year 1914 what was the average amount of acid used?

A. It is shown to average 10.17 pounds per ton of flotation feed or 9.38 pounds per ton of original mill feed.

Q. 44. The paper also shows, for example, the average for the year 1915, does it?

A. Yes.

Q. 45. If so, please read it.

A. The average oil consumption per ton of flotation feed for the year 1915 is shown to be 1.05 lbs.

Q. 46. Of acid?

A. The acid is shown to be 9.94 lbs. per ton of flotation feed.

Q. 47. For the year 1916?

A. For the year 1916 the oil consumption is shown to be .70 lbs. per ton of flotation feed and the acid consumption is shown to be 10.19 lbs. per ton of flotation feed.

Q. 48. What does the last column of the exhibit show?

A. It shows our record of the oils used during the different months since we have operated.

Q. 49. Have you brought with you a key that will explain that record?

A. Yes.

Q. 50. THE COURT: What is the difference between the original feed and the flotation feed?

A. The difference between the gravity concentrate,

which is taken out in the gravity portion of the mill, and the total feed.

Q. 51. BY MR. ~~KREMER~~ Kenyon: The original feed; will you explain that a little more fully, as contrasted with the flotation feed?

A. The original feed is the entire original ore received for treatement at the head end of the mill.

Q. 52. Indicated at the very top of your flow sheet?

A. Yes. The flotation feed is the portion of the original feed that reaches the flotation, and is represented by the difference between the original mill feed and the concentrate which we take out in the gravity section of the mill.

MR. KENYON: Plaintiff offers in evidence the paper last produced by the witness being the oil key, and the same is marked Plaintiff's exhibit No. 248.

Q. 53. Will you explain, now, this oil key that you have produced?

A. The oil key simply shows the oils which have been used in both our copper and zinc sections, by our own Timber Butte numbers for these oils. For instance, in August, 1914 the oil key shows that oils No. 6 and No. 140 were used; that is, Timber Butte Nos. 6 and 140. The oil key simply states briefly the type of oil and the producer.

Q. 54. For example, T. B. No. 6 is what?

A. It is a crude turpentine oil produced by the Georgia Pine & Turpentine Company.

Q. 55. What does L03 mean, occurring after

William Nichols Rossberg.

crude turpentine opposite the number T.B. No. 6 in the oil key?

A. I suppose that is simply a trade name.

Q. 56. That that particlar oil used by you at that time bore?

A. For that particular oil; probably simply a trade designation that the producer gave it.

Q. 57. T B 140 is shown to be what?

A. T B 140 is oleic acid produced by C. T. Perry & Co., of Helena, Montana.

Q. 58. And so throughout the entire list?

A. Yes.

Q. 59. Now, as to the extent of the use of this process in that mill, can you produce some figures for us from the original records of the company?

A. I have a brief outline here showing the tonnage of zinc ore treated in the zinc section from the first of 1915 up to and including the first three months of 1917.

MR. KENYON: Plaintiff offers the paper produced by the witness in evidence, and it is marked plaintiff's exhibit No. 249.

Q. 60. Will you now explain the figures appearing on this exhibit?

A. The first column shows the date; the second column is the tonnage of original mill feed; the sheet shows a tonnage of 160,461 tons treated during the year 1915. The tons treated during the year 1916 were ~~was~~ 201,455 tons. For the first three months of 1917 we treated 41,956 tons. That ~~This~~ makes a total of 403,-

872 tons for the period shown. There was also some ore treated during a portion of the year 1914, during the time that we operated.

Q. 61. Can you state what that tonnage was?

A. That tonnage was 67,107 tons. That makes a total tonnage treated in the zinc section of 470,-980 tons.

Q. 62. Now proceed with the explanation of exhibit 249. What does the third column show?

A. The third column shows the assay of the original feed in per cent of zinc. The average for the year 1915 is shown to be 16.72% zinc. The average for 1916 was 13.38 and the average for the first three months of 1917 is shown to be 17.43. I might state that, taking the fractions, the tonnage treated during the time I detail, for 1915, 1916, and three months of 1917, is one ton greater than what I gave—that is, considering the fraction which is on the report here. The sheet also shows the tonnage of gravity concentrates produced as a zinc concentrate, as a copper-iron concentrate, and as a lead concentrate.

Q. 63. Those concentrates are separated by the water concentration part of the mill?

A. Yes.

Q. 64. And go to separate bins as shown in your flow sheet?

A. Yes.

Q. 65. Now, proceed. You need not read the details of those figures; go to the next column, flotation feed.

William Nichols Rossberg.

A. The flotation feed is the difference between the original feed and the gravity concentrates, both as to tonnage and assay.

Q. 66. That is to say, the three gravity concentrates are added together and subtracted from the original mill feed, and the remainder is the flotation feed tonnage?

A. Yes, sir.

Q. 67. And that is how you get the figure, 148,036.83 for the year 1915, etc.?

A. Yes, sir.

Q. 68. And how is the figure "assay percentage zinc in flotation feed" obtained?

A. It is arrived at in the same manner; that is, the total zinc contained in the gravity concentrate is subtracted from the total zinc in the original mill feed, and a new assay per cent is calculated for the flotation feed.

Q. 69. Now, what is the next column?

A. The next column shows the flotation concentrate in tons and in assay per cent of zinc.

Q. 70. That is the result of the flotation operation?

A. As near as we could get at it, that is the result of flotation.

Q. 71. Now, what is the next column, total mill tailings?

A. The total mill tailing is the tailing from the rougher machine, including the zinc in the solid material, and also the small amount of zinc in solu-

tion in the tailing water. It is the total mill tailing which leaves the mill.

Q. 72. That is an actual measurement?

A. It is an actual assay, with an automatic sampler; a daily assay, and the tonnage, of course, is the difference between the original feed and the total concentrate shipped.

Q. 73. Now, what is meant by the four columns under the head "Recovery of Zinc in Original Mill Feed"?

A. The first two columns indicate the recovery of coarse and fine zinc concentrate determined in two manners; the second two columns under that heading are the recovery of zinc in all of the concentrates produced, determined in the two different manners.

Q. 74. Those two different ways that you speak of are what?

A. The first shows the recovery by weight and assay of the concentrate against the weight and assay of the original feed. The second is the weight and assay of the concentrates against the tailings assay.

Q. 75. Those ways of figuring the recovery are both proper ways of figuring recovery, are they; they check each other?

A. They are both reliable, and usually check each other, if all the assays are correct.

Q. 76. You have applied those two ways first, to the fine and coarse zinc concentrate produced, and secondly to all the concentrates produced, in columns 1, 2, 3, and 4?

William Nichols Rossberg.

A. Yes.

Q. 77. And finally, the last two columns, headed "Estimated Recovery of Zinc in Flotation Feed" how are those figures obtained?

A. The last two columns represent the calculated flotation recovery against the flotation feed.

Q. 78. Calculated first in one way and then in the other way that you have explained?

A. Yes.

Q. 79. So that in the middle of the table under the heading "Flotation Concentrate" and the second column under the heading "Assay Per Cent Zinc," is given what we have called the grade of the flotation concentrate in zinc contents?

A. Yes.

Q. 80. And in the last two columns of the exhibit are given what we have called the recovery by flotation, expressed in zinc recovery?

A. Yes; against the flotation feed.

Q. 81. Now, will you please in a similar way, describe the copper section of the mill producing a flow sheet for that purpose if you have one?

A. I have one.

MR. KENYON: I offer in evidence the flow sheet produced by the witness and it is marked plaintiff's exhibit 250.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 250.

Q. 82. Please describe that copper section from that flow sheet?

William Nichols Rossberg.

A. The copper ~~upper~~ section is simply a flotation section within the Timber Butte mill used for that purpose. No. 1 in the flow sheet indicates the tailing pile of the Colusa-Parrot copper tailings, at the old Butte Reduction Works and No. 2 is the electric crane—the tails are simply excavated with an electric crane and are ~~is~~ loaded on to railroad cars and sent up to the mill, to No. 6, which is the storage bin from which the tailing is fed by an automatic feeder and by spouts to elevator No. 8, thence to Akins and Dorr classifiers No. 9 and 10 to two Hardinge's ball mills No. 11. The tails are ground fine enough to overflow the Akins and Dorr classifiers and are then passed to a sludge tank No. 12 serving as a storage tank for inequalities in the feed, and then from the sludge tank the pulp is sent to flotation machines 13 and 14. No. 14 is a 20 cell machine of the standard Minerals Separation type and No. 13 is a 14 cell standard Minerals Separation machine. The first 13 cells of No. 13 and the first 19 cells of No. 14 produce a finished copper concentrate which is sent to No. 16, three Dorr thickeners, which thicken the concentrate for filtering through No. 18, two Portland filters. From the concentrate bin 19 the filtered concentrate is loaded onto railroad cars No. 20, for shipment to Anaconda, to the Anaconda Smelting plant. The last cell in each of the two flotation machines produces a middling which is returned to the head of the flotation machine in closed circuit.

William Nichols Rossberg.

Q. 83. Through elevator No. 15?

A. Through No. 15, an elevator.

Q. 84. To sludge tank 12?

A. To sludge tank 12. The tailing from the two flotation machines is sent to waste.

Q. 85. When did this copper section begin operation?

A. The copper section was started in May, 1916.

Q. 86. And has been in continuous operation ever since?

A. And has been in continuous operation ever since.

Q. 87. And what has been the total tonnage treated in this copper section?

A. The total tonnage up to and including the month of March, 1917, was 89,453 dry tons.

Q. 88. What amount of oil has been used in the operation of this copper section?

A. The average amount of oil for the year 1916 was 2.83 pounds per ton of original feed or in this case per ton of flotation feed.

Q. 89. And in the three months of 1917, the first three months?

A. The average for the first three months of 1917 was 2.28 pounds per ton.

Q. 90. And how much acid was used?

A. The average for 1916 was 9.38 pounds per ton and the average for the three months of 1917 was 5.87 pounds per ton.

Q. 91. What was the average copper content of the feed of this copper section?

A. 9.97 per cent copper.

Q. 92. What has been the assay of the tailings on an average?

A. The average tailing in 1916 was 0.266 per cent copper; the average for January, 1917, was 0.258 per cent copper. The average for February, 1917, was 0.218 and the average for March was 0.210.

Q. 93. What was the average grade of concentrate produced?

A. The average grade of concentrate for 1916 was 9.085 per cent in copper with 10.43 ounces in silver; 0.02 ounces in gold, 22.8 per cent iron; 26.5 per cent insoluble. I have the average grades for the individual months of 1917, if you wish them.

Q. 94. Please give them?

A. The concentrate produced in January averaged 8.07 per cent for the copper; 9.43 ounces for the silver; 0.0167 ounces for the gold; 22.93 per cent iron; 31.53 per cent insoluble. The February assay average was 7.95 per cent copper; 8.81 ounces for the silver; 0.0198 ounces for the gold, 20.5 per cent for the iron; 34.2 per cent for the insoluble; and the averages for March, 1917, were 8.13 per cent for the copper; 10.04 ounces for the silver; 0.02 ounces for the gold; 20.22 per cent for the iron; 32.48 per cent for insoluble.

Q. 95. And where does the ore come from that is fed to this copper section and concentrated there?

A. This ore is—the copper ore is the copper tail-

William Nichols Rossberg.

ing at the Butte Reduction Works or works at Butte, produced by the Colusa-Parrot Company.

Q. 96. Is it a rejection of former processes practiced at the reduction works?

A. It is a reject from water-gravity concentration.

Q. 97. What is the surveyed tonnage of that dump of reject?

A. Approximately 900,000 tons.

Q. 98. And what is the copper content, average copper content of that dump?

A. The average content for the entire tailing was shown to be 1.05 per cent copper, by thorough sampling.

Q. 99. And the silver?

A. The silver as I remember it was 1.16 or 1.19, one of the two figures.

Q. 100. Ounces per ton?

A. Ounces per ton.

Q. 101. What was the value of that copper and silver in that dump estimated at the market price of 25 cents per pound for copper and considering the cost of treatment as you treat it in your copper section?

A. Well, the profit per ton right now would be approximately two dollars.

Q. 102. $1,800,000 for the entire dump?

A. Yes, sir.

Q. 103. Where, in the flotation processes that you have described, you return middlings to the head of the same machine, why do you do so? What is your purpose?

A. Simply to increase the grade of the concentrate without injuring the tailings.

Q. 104. Do you do it to save oil?

A. No, sir, we have never returned middlings for that purpose.

Q. 105. Have you ever observed that it did save oil?

A. I can't say whether it saves oil or not.

Q. 106. You have not observed that it has?

A. I haven't noticed any.

Q. 107. You have not figured on saving oil in that way?

A. No, sir.

Q. 108. Now with regard to the relation of the amount of sulphide mineral that happens to be present from time to time in the ore being treated, to the amount of oil used or required, have you ever noticed or observed any relation between them such that when the sulphide increases the amount of oil must be increased and vice versa?

A. I have never noticed any increase due to mineral content.

Q. 109. Practice has never demonstrated to you that any such rule actually holds good?

A. No, sir.

MR. KENYON: The witness is yours, Mr. Scott.

CROSS EXAMINATION

BY MR. SCOTT:

X-Q. 110. Is there any sub-aeration in any of your machines in either of these plants, air coming in from the bottom?

P. 4385, After L. 5, insert "A. I don't suppose it is quite."

William Nichols Rossberg.

A. No, sir.

X-Q. 111. Now, is the pulp level regulated at the same relative height in the rougher cells and in the cleaner cells of the zinc section?

X-Q. 112. Intentionally is it made different in one than the other?

A. I wouldn't say for sure what the practice of the operators is right at present, but there was a time when the levels of the pulp in the cleaner cells was in question. I have not noticed the machines from that point of view recently. I don't know what they would show.

X-Q. 113. This time you speak of the level in the cleaner cells, what was it; what did you say, lower or higher?

A. Well, there was considerable doubt what the proper way to run them at the time I was noticing them was.

X-Q. 114. Did you finally decide on any way to do it, that it should be higher or lower?

A. The decision was made by the flotation foreman. I have not followed the matter to date.

X-Q. 115. You never noticed it since the foreman has decided this and began to operate the cells?

A. Noticed the depth of the froth?

X-Q. 116. Yes, and the level of the pulp in the roughers and cleaners.

A. I wouldn't say for certain, but I would say—it was my impression that the pulp is carried thicker on the cleaners.

William Nichols Rossberg.

X-Q. 117. Than on the roughers.

A. Than on the roughers.

MR. KENYON: The witness seems to misunderstand you. He says pulp.

THE WITNESS: You mean the depth of the pulp?

X-Q. 118. MR. SCOTT: Yes, the depth of the pulp. That would be the same as saying that the pulp's level was lower in the cleaners than in the roughers, wouldn't it?

A. That is what I took your question to mean.

X-Q. 119. Where do you add acid in the zinc sections?

A. In the sludge tank, preceding the flotation work.

X-Q. 120. Can you form any idea as to about the time interval it takes for the pulp to go from the sludge tank to the flotation machine, that is whether it would be minutes or hours, on the average?

A. Well, it would be a question of minutes through the flotation machine, I presume.

X-Q. 121. Be some minutes, you think?

A. Well, I really couldn't tell. I have no definite knowledge of the time required to go through our flotation machines.

X-Q. 122. And where is the oil added?

A. The oil is added at the first cell of the rougher machine in our zinc section.

X-Q. 123. Do you use any other reagents than the zinc—any other reagents in your zinc section?

A. I might add that at times we have added oil in the middle of the machine, but our practice right at the present time is to add the oil at the first cell.

X-Q. 124. And do you use any salt or mineral reagents in the zinc section?

A. No, we do not.

X-Q. 125. Can you state whether the pulp is more —or is as dense when it reaches the flotation machine as it is in the sludge tank?

A. I haven't made any—I have never conducted any experiments along that line at all.

MR. SCOTT: That will be all.

(WITNESS EXCUSED.)

The witness notes in reading the above that the word "pulp" in his answer to X-Q. 116 should be "froth."

CHARLES H. FULTON, Called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION:

BY MR. WILLIAMS:

Q. 1. Please state your name, age, residence and occupation?

A. Charles H. Fulton; 43; professor of metallurgy in the Case School of Applied Science at Cleveland, Ohio; residence, Cleveland, Ohio.

Charles H. Fulton.

Q. 2. Please state your experience in matters relating to mining and metallurgy?

A. I am a graduate of the Columbia School of Mines, Columbia University, New York City, in 1897. My first experience in practice was as superintendent of a gold mine near Redcliff, Colorado. I held that position for two years. After that I was instructor in metallurgy at the University of Wyoming for two years. After that I was professor of metallurgy at the South Dakota State School of Mines, Rapid City, South Dakota, for five years. After that I was president of the South Dakota State School of Mines until 1911. From 1911 until the present time I have been professor of metallurgy in the Case School of Applied Science. During 1906-8, while employed at the South Dakota State School of Mines I also held the position of consulting engineer and manager for the Standard Smelting Company at Rapid City. During my residence in the West I have examined a large number of mining properties in South Dakota, Colorado and Idaho, and have done other professional metallurgical work in a consulting capacity. In connection with my educational work every summer I have had occasion to visit metallurgical centers with classes of students and in this manner I have seen a very large number of mills and metallurgical works in the United States and have become intimately acquainted with the practice of this art. I have seen flotation carried on at the Inspiration mines, the Miami mine, and the Old Dominion mine in Arizona and at the

Anaconda plant in Montana, and at the Magna mill of the Utah Copper Company in Utah.

Q. 3. Please explain the methods employed in the practical work of concentrating ore up to March, 1905.

A. I shall take the liberty of referring to my notes in this connection. The final recovery of metals from their ores is accomplished in most instances by a smelting operation. This is particularly true, of copper, lead and zinc, and to a considerable extent for gold and silver, although the two latter metals, especially gold, are also recovered by the so-called wet process, in which chemical solutions are employed. This is done to some extent for ores of zinc; copper in a minor degree is recovered by wet methods. The great bulk of all the metals except gold is recovered by smelting operations. In order to smelt economically it is necessary that the furnace charge be high in metal content. Thus, for instance, in zinc smelting it is necessary that the ore charge into the retort of the distilling furnace contain not less than about 40 per cent of zinc.

In smelting copper concentrates in reverberatory furnaces, the same general condition holds true, except that a lower copper content, say from 8% upward, according to conditions, is required.

Ores with this high metallic content are relatively uncommon and the great bulk of ores is of low metal content, in fact at the present time, great quantities of copper ore as low as 1.5 to 2 per cent copper are worked at good profit. Before the metal in these low

grade ores can be recovered economically by smelting it is necessary to *concentrate* the metallic minerals into a small bulk of high grade material. This is done by removing a portion and in some cases nearly all of the worthless gangue, the operation being known as concentration. The gangue of the ore is the non-metallic part of the ore, or the earthy minerals such as common quartz, the lime carbonate and such barren rock as may be mixed with the ore.

COMMON PROCESS OF CONCENTRATION. The common process of concentration consists in crushing the ores and submitting the crushed product to the action of water currents in different forms of apparatus whereby the heavier metallic minerals are separated from the lighter gangue chiefly by virtue of the difference in specific gravity between the two kinds of minerals. In order to effect the separation it is necessary to so crush the ore that the metallic minerals be freed from the enclosing gangue after the manner that the kernel of a nut is freed from the enclosing shell. It is evident that if the valuable metallic mineral occurs in relatively large pieces or crystals, the crushing may be coarse, but if the valuable mineral occurs finely disseminated in small particles the crushing must be fine in order to free the valuable mineral from the gangue.

It is well known that many of the metallic minerals, particularly the sulphides of lead, copper, silver, etc., are much more brittle and friable than the gangue so that in the process of crushing the amount of fine par-

Charles H. Fulton.

ticles of these minerals produced is relatively much greater than that of the fine gangue particles. These very fine particles of metallic mineral and gangue are known ~~as shown~~ as slimes. The above facts would not have any particular significance except for the phenomenon that the fine slime particles do not obey the laws by means of which large and moderate sized particles are recovered in the ordinary process of concentration, and hence in a large measure are lost.

In ~~concentration~~ connection with concentration practice, slime is solid matter in such a fine state of subdivision that the viscosity of the medium in which it is suspended is able to retard the velocity of its settlement by imparting to it a virtual specific gravity less than normal. Applied particularly to the metallic minerals in a fine state of subdivision this ~~seems~~ means that the small mineral particles act as if they had a specific gravity approximately that of the moderate sized gangue particles. Since in concentration it is the difference in specific gravity which causes the separation of valuable mineral from gangue, anything which causes the virtual specific gravity of the valuable mineral to approach that of the gangue will cause the valuable mineral to join the gangue and thus be lost.

It is apparent from the above that from the standpoint of the ordinary concentration process the production of slimes is to be avoided as much as possible, for, while a wealth of apparatus exists for the recovery of slime, such as slime concentrating tables, canvas tables and buddles, none of these make high recovery

and they simply represent the best there is available for the purpose.

However, in endeavoring to avoid the production of slimes, another serious difficulty arises which leads to conditions as bad, if not worse than the production of slimes. With ores that have the valuable mineral disseminated in comparatively fine particles throughout the mass of gangue, fine crushing is essential in order to free the particles of valuable mineral. If this be not done, and particles of valuable mineral remain attached to particles of gangue, the specific gravity of the piece is such that it will probably not join the concentrate but will pass out with the gangue and thus be lost. Or if it is recovered, it carries with it the objectionable gangue.

It is therefore evident that in the ordinary process of concentration a balance must be struck between fine crushing, which will produce a large amount of slime, and such a degree of crushing as will produce but little slime but will permit valuable mineral to remain locked up in the gangue. If methods were at hand for a substantially complete recovery of the valuable mineral in the form of slime, fine crushing would lead to very high extraction of valuable mineral from the ore, but all known methods and devices of the ordinary concentration system when applied commercially fall far short of complete recovery. The ore is therefore crushed to such a degree in each individual case as will yield the economic recovery under the existing circumstances.

Charles H. Fulton.

While the foregoing statements represent facts that are a matter of common knowledge to metallurgical and mining engineers it is desirable to confirm them by quotations from the writings of the foremost authority of the world on ore-dressing, Professor R. H. Richards.

ORE DRESSING, Vol 1, page 303.

Q. 4. This book that you have produced, when was it published?

A. It is the edition of 1903.

Q. 5. Have you any knowledge personally of the fact that this book was published in 1903?

A. I bought this particular volume in 1903; the date is marked in the book.

Q. 6. With your signature?

A. Yes.

MR. WILLIAMS: I think it is admitted that this is a publication of 1903.

MR. KREMER: It is certainly not disputed, Mr. Williams.

Q. 7. And volume 2, what is the date of the publication?

A. 1905.

Q. 8. And did you purchase that book at the time of its publication?

A. Yes, I did. That is not my own copy, however.

Q. 9. Have you these quotations in your notes so that you do not need to refer to the book?

A. I have.

"Extent of crushing desired. At first sight it would

Charles H. Fulton.

seem desirable to crush rock down to a size which shall be equal to the size of the smallest particle of valuable mineral. This would ensure perfect separation. In practice, however, there are several objections to this plan. It causes all the coarser particles of valuable mineral and gangue which are unlocked at larger sizes, to be crushed unnecessarily, thereby using an extra amount of power and causing an increase in the amount of slimes which are difficult to separate and which cause loss. This trouble of slimes is aggravated by the fact that in a majority of cases the valuable mineral is softer than the gangue and hence slimes more. For all these reasons it is an advantage in most cases, except where the mineral is all finely disseminated to crush first to a much coarser size than the finest particle, then to separate out as much clean mineral and clean gangue as possible, and to recrush the residue. This process can be repeated indefinitely, but in practice the added cost and the mechanical difficulties limit the number of repetitions to one or two. The ideal thing in crushing would be to have every grain of mineral remain intact and be entirely cleaned from all adhering particles of gangue. This is impossible to obtain in practice and there will always be some particles of mineral which are entirely surrounded by gangue. Such particles are known as attached or included grains and help to make up the middling product in the subsequent separation."

Vol II, page 1120. "The slime question is one point on which the author believes there is much room for

P. 4394, L. 26, after "which" insert "have particles of gangue attached to them or which"

Charles H. Fulton.

improvement. In discussing this question there are two ideas to be considered: First, the means of preventing slimes as far as possible; second, the arrangement for treating such as are unavoidably made. For the prevention of slimes the use of graded crushing, graded sizing and graded jigging is probably the greatest help. This has been previously discussed in several places in the book and needs no further explanation here. For the crushing, rolls are to be preferred, in general, to stamps and most other fine pulverizers. Only on rare occasions, as for the very fine crushing of middlings, is the use of stamps justifiable. On a soft galena-blende ore at Ramsbeck, in Westphalia, the grizzley has only 30 mm. spaces, instead of the usual 50 or 60 mm. This sends finer ore to the cobbing and avoids much of the fines which would be made if the stuff between 30 and 60 mm. were crushed directly by machine. While graded sizing will save losses by slimes, yet, when carried to extremes, the advantage desired may be lost owing to the large amount of attrition which results from the rounding of the grains in passing the ore over the large number of screens and concentrators necessary when close sizing is used. This attrition causes losses in slimes. Attrition may occur in other ways, and to keep it down all unnecessary handling of the ore should be avoided and the necessary handling should be done by proper machinery. For example, the use of centrifugal pumps, especially of the radial discharge type, is to be condemned for elevating soft ores like galena; bucket ele-

Charles H. Fulton.

vators would be better. There is one loss from attrition that cannot well be prevented, and that is from the wear that occurs in the bed of a jig. Slime losses may be reduced by taking care that where the coarse is separated from the fine it be thoroughly done. By exercising this care not only will losses of slimes be saved, but the washing of the coarser material is better and easier done. Examples of losses of slime from its being mixed with coarse are on jigs which are fed imperfectly with classified materials, slime table and vanners fed with extremely fine pulp mixed with the coarse. On the slime tables the very fine concentrates are lost on the sand side of the table, while on the vanner they pass down with the tailings. The remedy for both of these losses is to separate out the extremely fine and treat it by itself. Greasy flotation is a source of slime loss which may be partly prevented by making sure that the ore is thoroughly wetted at the start and that during the course of its treatment it does not have an opporunity to partly dry again. The actual treatment of fine slimes is by no means an easy problem. Some mills, for example, settle the whole overflow of their classifiers and send these settlings directly to the smelter without any further treatment. Extremely fine slimes should not ordinarily be treated on a vanner, but rather on a slime table or a canvas table, because the shaking motion does not allow the fine particles to settle out of the rapid upper layer of the water."

Vol. I, page 4. "Greasiness. This is the term used

to express the tendency of minerals to float on the surface of water as if they were greasy. It is caused by the aversion of the surface of the particle to become wetted. The particle may carry an air bubble down with it, which later floats it to the surface, or its dry surface may prevent its sinking at all, the particle floating at the base of a little dimple or depression on the surface of the water. This causes much trouble in ore-dressing. All minerals exhibit the tendency, but with some species it is very marked; for instance, in native copper, native gold, cassiterite, sphalerite, graphite, and some of the silver minerals. This property may be regarded rather as a difficulty to be overcome than as a help, for the reason that it cannot be depended upon—at one moment a given grain will float, at another it will sink. An approach towards a useful effect may be gained by forcing large quantities of air in fine bubbles to the bottom of the sand in a water tank. The floating scum when caught by gentle dipping transverse gates often gives a higher assay than any product in the mill."

Vol. II, p. 890. "Greasy Flotation. When particles refuse to become wetted they may float in a little dimple in the surface of the water, or if immersed they may retain attached to them air bubbles which float them up later. This principle, however, is so unreliable and difficult to control that it is usually considered more an injury than a benefit."

Vol. II, page 1119. "Tendency and Future. The tendency is distinctly toward graded crushing, graded

Charles H. Fulton.

sizing and graded washing. The jigging of larger sizes is being experimented upon until certain mills are jigging 1 to ~~1/5~~ 1½ inch stuff with good results in the prevention of slimes and in diminishing the cost of crushing. Although the invention of tables of the Wilfley type has given some strength to the plan advocated by Hallet and Bartlett of breaking the whole lot of ore to a small size before abstracting any portion of the values, yet this scheme seems destined to be of limited application only, since the former scheme has too great advantages over it; the lump ore is not slimed with its resultant losses, and the power for crushing is saved. The future progress to be made in ore dressing will probably be more in the development and perfection of existing processes and machines than in the introduction of new processes. Not that new processes do not appear—for they are brought out constantly—but their disappearance is usually as sudden as their appearance. The modern wet concentration method seems eminently suited to most of the problems, but it is weak or altogether fails when there is only a slight difference in specific gravity between the mineral and the gangue, or when water is lacking, or when dealing with very fine slimes. Under these conditions it becomes necessary to make use of some one of the several processes given in Chapter XVIII of the book. For separation in such cases a broad theoretical basis is lacking."

The chapter 18 referred to includes "operations of occasional application, such as magnetic concentration,

Charles H. Fulton.

roasting for magnetism, pneumatic concentration," and the following line of processes:

"1. Separation by centrifugal force.

"2. Roasting by porosity.

"3. Heating for decrepitation.

"4. Disintegration followed by screening.

"5. Disintegration followed by settling or elutriation.

"6. Weathering.

"7. Adhesion."

Under adhesion, the Elmore process of bulk oil flotation is described on page 831 of Vol II.

"Theoretically the proper application of principle should have a perfect separation with a given ore. Practice, however, seldom, if ever, obtains such results, and the chief reasons for imperfect work are given in the order of their importance below.

(a) Fine slimes.

(b) Included grains, meaning grains still attached to or surrounded by gangue.

(c) Flattish grains.

(d) Compact grains, which has an effect if the concentrator is run too fast.

(e) Oxidized, or weathered grains."

Quotation from Vol. II, page 892.

"Considering mills 1 to 43 inclusive, we have the valuable mineral contained in the form of sulphide, associated with gangue. We have, after crushing, the valuable mineral existing, as

(a) Compact grains,

Charles H. Fulton.

(b) Flattish grains,
(c) Included grains,
(d) Fine slimes."

Whereupon an adjournment was taken until 2 p. m.

2 p.m. May 10, 1917.

The compact grains (a) are easily separated unless the machines are run too fast. The flattish grains (b) are difficult to separate owing to their slowness in settling. The included grains (c) prevent a perfect separation since they oblige us to send gangue into the heads (Concentrates) and values into the tailings, or else make a middling product requiring retreatment. This middling product will include also some of the flattish grains. The fine slimes (d) are saved with difficulty because they settle so slowly and are so easily carried forward by water current that the commercial limit is reached before the last of the values is saved."

From the foregoing explanations and citations it is evident that the common process of concentration is far from perfect and that there is much room for improvement. Its chief imperfections lie in its inability to deal satisfactorily with slimes, or the ~~way~~ very fine particles produced during crushing, and hence in most instances the operations of the process are conducted in such a manner as to prevent as far as possible the production of slimes. The avoidance of slimes, however, carries its penalty with it for if slimes are avoided part of the ore is insufficiently crushed and the so-

called "included grains," previously defined, appear and cause difficulty, for they are apt to be lost by joining the gangue, and if they are separated out as a middle product, they must be recrushed to a fine state, thus giving rise to a certain amount of slimes. In exceptional ores that contain the valuable mineral in comparatively large grains the slime question may not be a very serious one, and recoveries of between 80 and 90% of the valuable mineral are possible, but if as usual the ores contain the valuable mineral disseminated throughout the mass in fine and very fine grains it is necessary to crush all the ore to a fine state at the very beginning of the concentration operation with the consequent production of a large amount of slime.

If average disseminated copper ore be taken as the basis for a calculation, the ore will contain 1.82% copper. This is equivalent to 36.42 pounds of copper per ton of ore. The average recovery or yield by the ordinary concentration process on this type of ore may be taken as about 70% (maximum), equal to 25.5 pounds of copper per ton of ore. The loss therefore is 10.9 lbs. of copper per ton. The above recovery is the best obtainable by very careful work aided by extensive installations of slime saving devices, such as thickeners, tables and buddles. The recovery by smelting may be assumed to average 92%, so that an ore containing 36.42 lbs. of copper will yield 23.46 pounds of copper bullion. This at 14 cents is equal to $3.28. The total cost of production of the copper in a ton of ore must therefore be less than this. In some instances

Charles H. Fulton.

the cost approaches closely to this figure so that the margin is small indeed. If a marked drop occurs in the price of copper, the margin disappears and may turn to a loss.

If a comparatively simple process were found to replace the elaborate and imperfect slime concentration system now commonly in use, and which would increase the extraction or yield to 90% of the copper in the ore and above, and at no greater cost, it is perfectly evident that considering the tremendous interests involved, such a discovery would be considered epoch making in the mining industry.

Further, if this process were applicable to lead and zinc ores, in the same manner as for copper ores, it would take on even greater importance, and be entitled to rank as one of the great inventions of the metallurgical art.

The bothersome slimes problem would disappear, as slimes could be treated without difficulty. Fine crushing could be resorted to so as to liberate practically all mineral particles from gangue, and the loss from included grains be avoided. The whole concentration system could be much simplified, for in place of the complicated crushing in stages, graded sizing and graded washing, the ore could be at once reduced to fines by two or three crushings, and the fine product treated, the sand by water concentration, the slime by the simple new process in question, or the whole product be treated by the new process.

I have now described the art as it existed in the mills

Charles H. Fulton.

and the expectations of the art as expressed in its literature on and about March, 1905, and where I have used the term concentration, or the term "common process of concentration," I have referred to the then known water concentration processes that I have described.

Q. 10. Now, today, where flotation is not in use is or is not this process of water concentration the process of the art?

A. Yes, it is.

Q. 11. Were you one of the parties representing the plaintiff who went to the Magna plant of the Utah Copper Company during this trial and observed the operations being conducted at that plant?

A. I was.

Q. 12. I show you plaintiff's exhibit 245, flow sheet, Magna mill, Utah Copper Company, visit of April 22nd, and ask you whether or not that correctly represents the operations as they proceeded on that day?

A. It does.

Q. 13. Will you from your memory describe generally the operations that were conducted there and the observations made by you?

A. In the Magna plant there were two sets of Janney Flotation machines. The machines were treating the concentrate from Frue vanners. The concentrate from the vanners were collected and sent to a hydraulic classifier, the overflow from which, with a certain amount of underflow, passed to the Dorr thick-

ener and a number of settling cones. The thickened product from the settling cones and the Dorr thickener passed to a sludge box, and from the sludge box were fed to a Janney agitator known as emulsifiers, and from the emulsifiers passed to double spitzkasten cells, 17 in one machine and 16 in the other. The oil was fed below the sludge tanks in a separate box. I watched particularly the machine known as number 1 which had 17 double spitzkasten.

Q. 14. What did you observe in the spitzkasten of this machine?

A. I observed froth being discharged from the spitzkasten in cell Nos. 2, 3, 4, 5, and 6, which was led away as finished concentrate. The froth dis charged from other cells, that is from below six to 17, was returned to the sludge box as a middling. I observed the oil feed at the head of the emulsifiers and saw the tailings discharged from the machine. I further saw the addition of the reagent which is termed calura, both at the head of the machine with the oil and at a number of cells from the top towards the bottom.

Q. 15. Is this feed of the calura indicated in the flow sheet, plaintiff's exhibit 245?

A. Yes, that is correct.

Q. 16. What was the condition of things in the spitzkasten number 1 as observed by you?

A. Spitzkasten number 1 was not discharging material regularly. It was not provided with a discharge paddle. There was room for it there, but it was not

Charles H. Fulton.

in operation so that spitzkasten number 1 was we might say practically lying dormant and was not an active cell for the discharge of froth.

Q. 17. Does what you saw apply to both of the spitzkasten of cell number 1?

A. Well, if I stand at the bottom of the machine and look toward the head, the right spitzkasten number 1 was very inactive. There would be a little flow of material from its surface, perhaps five or ten minutes every hour. The left one, however, would discharge somewhat more frequently, although by no means regularly.

Q. 18. This matter of the discharge of the spitzkasten is that a matter of adjustment of levels?

A. Yes, there is a valve on each spitzkasten, the amount of opening or closing of which determines the overflow over the lip of the spitzkasten.

Q. 19. Was a specimen taken from spitzkasten number 1?

A. It was.

Q. 20. What have you to say as to that specimen? What was it a specimen of?

A. The specimen was that of a float—of the float on top of the spitzkasten. It was very oily in appearance and when taken on a glass disc or watch glass—a large one—and wetted down with water it seemed to divide itself into three compounds; first, a sort of floating oily emulsion carrying traces of mineral and, second, oil-air bubbles, like frog spawns, call it, carrying very little mineral and easily separated from the rest

of the material by panning, and third, the ordinary agitation froth, but in small amounts.

Q. 21. Now, what did you observe and what was done as to the second spitzkasten?

A. The second spitzkasten was discharging the agitation froth regularly. It had a more oily appearance than froth that I have seen at other mills.

Q. 22. And the third spitzkasten?

A. The third was very similar to the second, perhaps with somewhat less oil apparent.

Q. 23. And the fourth?

A. The fourth, like the third. The fourth spitzkasten, to my recollection, discharged more froth than the second or third.

Q. 24. Now, as to the fifth and sixth?

A. Like the fourth, except that the froth became somewhat less oily, quite noticeably so, on the fifth and sixth.

Q. 25. And the sixth, as you have described it, was the last one which discharged a finished concentrate?

A. The last one to discharge a finished concentrate.

Q. 26. Now, we come to No. 7; what did you observe on the surface of that spitzkasten?

A. No. 7 on the surface had a whitish gray froth in relatively small amounts, and small floating areas of oily material, a sort of oily float. The amount of froth on No 7 was very decidedly less than on Nos. 5 and 6. The overflow—the water level was carried much higher on No. 7 than it was on 5 and 6 and the froth more readily discharged.

Charles H. Fulton.

Q. 27. And now you might follow those spitzkasten down the line, making any further comments or grouping them together as you think best.

A. The amount of froth diminished as we progress from No. 7 down to No. 17. The amount of oily float also diminished very appreciably, so that on the lower ones of the machine this was not apparent. The only overflow there was the light-colored froth.

Q. 28. Now, were your observations and the taking of specimens confined to the spitzkasten at one side of these double machines?

A. They were; to the right side when facing the head of the machine.

Q. 29. Was that by agreement with the representatives of the defendant?

A. It was.

Q. 30. The matter of the determination of the amounts of oil and of the assays as to the amount of metal in the floats was not attended to by you, was it?

A. It was not.

Q. 31. What was done with the specimens that were taken?

A. We took all the specimens and transported them by a car, ourselves being present, to Salt Lake City, and there they were placed on the railroad train and delivered to the laboratory in Butte.

Q. 32. The laboratory of the plaintiff?

A. Yes.

Q. 33. At the time of the inspection by our representatives of the Butte & Superior plant, Sunday,

Charles H. Fulton.

April 29th, were you or were you not present in Butte?

A. I was not present.

Q. 34. You had gone back home for a time?

A. Yes.

CROSS-EXAMINATION.

BY MR. SCOTT:

X-Q. 35. Did you understand the process by which this froth was made which you saw in the plant of the Magna plant at the Utah Copper Company?

A. I believe I did, yes.

X-Q. 36. What was your purpose in going there to inspect the operations?

A. We went to the Magna plant to see in what manner the plant was operated and under what conditions it was operated.

X-Q. 37. Did you consider the operations that you saw at Magna as conducted according to the same process as the operations at the Butte & Superior mill?

A. I did not see the Butte & Superior mill.

X-Q. 38. Oh, you did not see the Butte & Superior mill; I beg your pardon. You have seen operations conducted at other mills, have you not?

A. I have.

X-Q. 39. By an agitation froth process?

A. I have.

X-Q. 40. At what other mills?

A. I have seen the process conducted at the Inspiration mill in Arizona, at the Miami mill in Arizona, at

Charles H. Fulton.

the Old Dominion mill in Arizona, and at the Anaconda mill at Anaconda.

X-Q. 41. Do you regard that operation that you saw carried on at Magna plant as exemplifying the same process that was carried on at Anaconda and Old Dominion?

A. I do.

X-Q. 42. The product you regard as being the same product that is formed at Anaconda and at Inspiration?

A. I do, yes.

X-Q. 43. I will say Old Dominion, because I think both of those have the mechanical agitation, haven't they?

A. Yes.

X-Q. 44. Do you know how much oil was used at Magna the day you were there?

A. Yes, I was present at the taking of the oil sample. I did not weigh up the oil, or make any calculations, but I was told that it was 21.8 lbs. per ton of feed.

X-Q. 45. Well, we will assume for the present that that is correct; I think it will be proved before we get through. How much oil were they using at Old Dominion when you were there?

A. I don't remember.

X-Q. 46. Have you any recollection whatever?

A. Well, it was a small amount; under 1%.

X-Q. 47. What was it at Anaconda, do you remember?

Charles H. Fulton.

A. I do not.

X-Q. 48. Do you know whether it was over or under 1%?

A. It was under 1%.

X-Q. 49. And you say that the same process was being carried on at Magna as was being carried on at Anaconda and Old Dominion?

A. Yes.

X-Q. 50. Now, I would like to read you a passage from your testimony given in the suit of Minerals Separation Limited against the Miami Copper Company. You testified in that suit, did you?

A. I did.

X-Q. 51. It will be from Volume I, page 428, beginning at X-Question 54: "X-Q. 54. Is it your opinion as an expert in this matter that the formation of this froth, referred to in the passage you quoted, is dependent upon the reduction of the quantity of the oil to a fraction of 1 percent of the ore? A. Absolutely, yes, sir. X-Q. 55. Is it your opinion as an expert that this froth will never result when the quantity of oil is more than 1 per cent of the ore? A. Not this froth, no, sir. X-Q. 56. Well, what other froth will result? A. A small scum, or perhaps a comparatively copious mixture of oil and air bubbles and gangue and metalliferous particles may rise to the surface if air and oil be mixed, but it bears not the slightest resemblance to the froth that is produced when the amount of oil is reduced to that which is specified in the patent in suit. X-Q. 57. You think you would be able to distinguish,

Charles H. Fulton.

do you, between the froth produced with less than 1 per cent of oil and one produced with over 1 per cent? A. I believe I could; yes, sir. X-Q. 58. You are not sure of it? A. Well, if the amount of oil is, say, .98 per cent in one case and 1.01 in the next case, I doubt whether I could. X-Q. 59. Well, we will give you a little more latitude. Suppose it was 2% in one case, and nine-tenths of 1 per cent in the other. Could you then distinguish? A. Well, nine-tenths is over the limit I believe." The last answer that I read was "Well, nine-tenths is over the limit, I believe." By that expression you mean that nine-tenths of 1 per cent of oil was an amount too great for the carrying out of the process of patent No. 835120?

A. Not necessarily, no.

X-Q. 52. What was your meaning?

A. Why, it means that with that amount—that with over that amount you could not produce the typical froth so that the froth would be apparent and be that froth only.

X-Q. 53. I asked you there in the last quoted question and answer if you could distinguish between a froth formed with 2% and one with nine-tenths of 1 per cent and your answer is: "Well, nine-tenths is over the limit, I believe. Now, I don't understand your explanation. Nine-tenths is over what limit?

A. Well, we were speaking of the froth, not of the process, as I understand you?

X-Q. 54. Yes.

A. Now, with that amount it would produce a float or froth which is distinguished from the froth of the process—distinguishable; you can tell the difference?

X-Q. 55. With nine-tenths of 1 per cent it would?

A. Well, somewhere near that, yes.

X-Q. 56. Let me state that over; I don't quite understand you. I will read again another passage from page 429, beginning with X-Question No. 64.

"X-Q. 64. Yes. And just what is the difference between these scums that are produced with 5 or 10 per cent., and those the patentees have discovered could only be produced with 1 per cent? A. The patentees' froth contains practically all of the mineral, and this other froth contained very little. X-Q. 65. You mean that the patentees, forming a froth with less than 1 per cent of oil, got practically 100 per cent of the valuable mineral in there? A. Not 100 per cent, but they got a very substantial mineral recovery. X-Q. 66. Yes. And you never have a substantial recovery then, with over 1 per cent of oil? Is that the thought? * * * X-Q. 67. Now, I think my last question related to what is the difference between these froths formed with less than 1 percent of oil, after the fashion of this patent in suit, 835,120, and those other floating masses that you have referred to as consisting of oil and air bubbles and mineral, and having a larger quantity of oil. What is the principal difference? What is the difference in phenomena, if your experience as an expert enables you to give us the distinction? A. Well, the froth which is produced by the very small quantity of oil, perhaps

Charles H. Fulton.

other matter, consists practically entirely of air and attached mineral. That is, the mineral is attached to the air bubbles. There may be a very large amount of air present; that is, the air may be large in volume, and the mineral may be relatively small or the mineral may be relatively large; that is, coating the bubbles very closely. That is a function of the amount of mineral which is present in the ore. On the other hand the froths or scums, or whatever they may be termed, magmas, which are produced when this greater quantity of oil is present, consist for the most part of the oil with some of the mineral that has been entangled and some of the gangue, and perhaps some air bubbles which have been forced into that mass.

"The difference, from a practical standpoint, is that the froth which is produced with this small amount of oil or other material contains the larger part of the mineral, while the other froth contains very little."

Is that correctly quoted?

A. Yes, it is.

X-Q. 57. Now, beginning at cross-question 73 on page 432: "Now, where does this change come, become the comparatively poor as you think, froth, with large amounts of oil and the froth which you think is much richer and has a small quantity of oil? Is there no sharp line of demarcation, or does it come all of a sudden, if your experience enables you to answer?

"A. Why, I think that the line of division is an extremely sharp one; that if the oil is present, say in 2 or 3 per cent of the ore, that phenomena happen which

rather tend to go over into the bulk oil flotation; that is, the oil itself has a tendency to entrap the mineral, to raise it to the surface. Of course, the effect with the amount of oil you have mentioned there is very slight, but if the oil be reduced to the quantity specified in the patent mentioned here, the physical phenomena change entirely from what I have seen." Is that correctly quoted?

A. Yes.

X-Q. 58. Is that still your opinion?

A. It is.

X-Q. 59. You have seen these photographs that were introduced in evidence of froth or were you away at that time?

A. I was away at that time.

X-Q. 60. I would like to begin reading with question 85 from the Miami record, page 434, question 85. "If you have explained it as well as you can, we will go on to something else. You have stated that this oil in these small quantities, something to the effect that it does not act as an oil any longer, and that you can do it with something else. What does that mean?

"A. That means that we can get that same froth, which contains valuable mineral, or a larger part of it, without what is technically known as oil, and with certain other substances like alcohol.

"X-Q. 86. Well, do they both do the same thing?

"A. Essentially, yes; they produce the same results.

"X-Q. 87. In the same way?

Charles H. Fulton.

"A. In the same way, I believe, yes.

"X-Q. 88. They do not involve any intricate differences whatever?

"A. I do not believe so." That was your testimony wasn't it, in the Miami case?

A. Yes.

X-Q. 61. I would like to read one question and answer, question 17, page 589, the answer to question 17. "Why, in the cyaniding of slimes pulp by agitation, the agitation must necessarily be very thorough and violent. At the same time that the agitation is carried on, it is essential that air be introduced into the pulp for the purpose of furnishing oxygen to dissolve gold in connection with cyanide, and also to destroy certain chemical salts which are formed and which would use up cyanide. The agitation of ore pulp in cyanidation is a prolonged one, as a usual thing, all the way from twelve to twenty-four hours, depending upon the ready solubility of the silver or gold mineral which is present." That was your testimony in the Miami case?

MR. WILLIAMS: I object. I think that the matter has gone quite beyond the limits. The mere fact that Prof. Fulton has heretofore testified on something which is wholly irrelevant to his direct testimony would not seem to me to warrant the question.

THE COURT: Yes, I think the objection is well founded. Sustained.

X-Q. 62. MR. SCOTT: In your visit to the Magna plant did you make any distinction between what was going on in say the first cell of the machine and that

which was going on in the second or third or the fourth or any other one?

A. Yes, I make a very decided difference. The first cell was not an active frothing cell, but in my opinion was a cell to remove oil and oil float, which it very successfully did.

X-Q. 63. Well, was what went on in that first cell the same process that you saw at Anaconda, and Old Dominion?

A. It was not.

X-Q. 64. It was not?

A. No.

X-Q. 65. Where did that process first appear?

A. In the second cell, the second being the first active cell.

X-Q. 66. You say it was not the same process merely because the froth was not overflowing at the time you saw it?

A. Why, the first cell could really not be considered as a frothing cell. You might just as well have had say a tank interposed between the sludge box and the first frothing cell as to have had that cell there.

X-Q. 67. Wasn't there any froth on it?

A. Why, there was some float rising to the surface but very little.

X-Q. 68. Wasn't there agitation going on?

A. Yes, there was some agitation, yes.

X-Q. 69. Just as much as in any cell, wasn't there?

A. There was no froth removed.

Charles H. Fulton.

X-Q. 70. There was just as much agitation in that cell as there was in any of them, wasn't there?

A. Just as much agitation there as in the emulsifier for instance.

X-Q. 71. Or in any other cell provided with spitzkasten boxes?

A. Yes.

X-Q. 72. And there was a circulation of pulp going on from the agitation box to the spitzkasten and back wasn't there?

A. I suppose there was some.

X-Q. 73. Just as much as in any of these, wasn't there?

A. There was no float being taken off.

X-Q. 74. I understand that.

A. So that the valves must have been perhaps closed down with very small degree of openings so the passing through would be very small.

X-Q. 75. What valves do you mean must have been closed?

A. Well, there is a connection between the agitator and the spitz. Now, I am not very thoroughly familiar with the Janney machine. I don't know the construction of the valve, but there must be some opening there.

X-Q. 75½. Well, don't you know that there is no valve on the circulating opening that permits the pulp to circulate from the agitating box into the spitz and back?

A. I am not familiar with the details of the Janney machine.

X-Q. 76. You said the valve must have been closed. But now you must have asumed that there was a valve there didn't you?

A. When I say "valve" I have reference to some connection between the agitator and the spitz, which I suppose was controlled by some arrangement.

X-Q. 77. Well, you really don't know anything about that, do you?

A. I know very little about the Janney machine.

X-Q. 78. Well, now, we have the agitation equal to the other cells as you state, and we have the froth. Now, that froth must have risen from agitation, mustn't it?

A. I didn't say we had froth.

X-Q. 79. Lets' call it whatever you want to?

A. Some little float.

X-Q. 80. Did it carry any mineral?

A. Why, very little; mostly oil.

MR. SCOTT: You asked for the report of the proceedings of that day and I would like to offer it now.

MR. WILLIAMS: I should like to examine it care fully before you offer it.

MR. SCOTT: This was asked for by you and you said you would accept it in this form and I have produced it for you and I offer it in evidenc.e

MR. WILLIAMS: I certainly am not going to accept any document of that kind until I have examined it. I didn't bind myself to absolutely accept anything that was handed to me.

MR. SCOTT: We will wait for you to examine it so we can proceed with the witness.

Charles H. Fulton.

MR. WILLIAMS: I will accept it in evidence subject to possible criticisms and the requirement of further proof. I cannot accept it absolutely.

MR. SCOTT: It is noted that the report consists of typewritten sheets with a blue print flow sheet attached.

Document admitted in evidence and marked DEFENDANT'S EXHIBIT 251.

X-Q. 81. Did you observe the floating mineral upon the surface of this spitz box of the first cell?

A. I observed the float there, yes.

X-Q. 82. And was the sample that was taken by your party a representative sample?

A. Yes, it was.

X-Q. 83. And the assay return of that sample shows it to have contained 18.98 per cent sulphide of copper, 19.4 per cent iron, and 27.3 per cent insoluble. Do you regard that as a useful or useless operation producing a concentrate of that grade?

A. That would depend what relation it bears to the regulation concentrate made in the plant.

X-Q. 84. Are you familiar with the regulation grade made there?

A. I am not.

X-Q. 85. And you have no independent idea of whether that concentrate made from a heading containing 7.095 sulphide of copper, 8.3 iron and 69 per cent of insoluble would be a useful operation and a good one metallurgically?

Charles H. Fulton.

A. I should say it was very poor concentrate to obtaind from such high heads.

X-Q. 86. I find from the report of the operation at Magna the day of your visit that part of the concentrate from spitz box number 10, carried 183.95 pounds of oil per ton, that is per ton of concentrate. Now, would you regard a concentrate carrying that amount of oil as being produced by the same process that you have seen at Anaconda and at Old Dominion?

A. It might be, yes.

X-Q. 87. You think that you could observe that amount of oil in that concentrate don't you, by the sense of touch?

A. Yes, easily.

X-Q. 88. Probably could see it with the eye, couldn't you?

A. Yes.

X-Q. 89. There would be no trouble about knowing it was there?

A. No.

X-Q. 90. You think the luster and color of the mineral would be covered up and concealed by that amount of oil?

A. Well, the product or concentrate there is something quite different from froth. It is a float, an oily float, which occasionally rose to the surface and is entirely distinct from the real product of the process, which is the froth. It is a by-product, something incidental, which arises, probably due to the excess oil,

Charles H. Fulton.

but it is not the froth in any sense of the word. It is something entirely distinct.

X-Q. 91. Did you state just at the end of your direct examination that wherever oil flotation was not in use water concentrating was the method? I am not sure I am stating it right, but I think that was the way you put it?

A. Well, I don't believe I said just that. I said the ordinary process of concentration was wet concentration. That is known as the common process of concentration.

X-Q. 92. What is used where oil flotation is not used for concentrating?

A. Of course water concentration is used widely. Some mills still use water concentration and some mills use water concentration in conjunction with flotation; some mill use flotation only. Then you might have a mill using what we term magnetic concentration, on certain ores.

X-Q. 93. And when you say "flotation" do you mean to confine it to oil flotation?

A. I confine my meaning to the agitation froth process.

X-Q. 94. With oil or an equivalent substance?

A. Some equivalent substance.

X-Q. 95. Do you know of any flotation process that does not employ oil?

A. Not in use at the present time, no, sir.

X-Q. 96. You do not know of its being in use, you say?

Charles H. Fulton.

A. You mean of oil only?

X-Q. 97. No, I mean of flotation without any oil.

A. I am not personally familiar with any. I haven't seen any.

X-Q. 98. You don't know that there are none?

A. There may be some, I don't know.

X-Q. 99. Now, Prof. Fulton, if that first cell at the Magna plant had been overflowing at the time you saw it—and I think some of the other witnesses said they did see it overflowing at times during the day—would you then have regarded the operation being carried out in that cell as a carrying out of the same process that you saw at Anaconda and Old Dominion?

A. Why, in respect to the small amount of real agitation froth that it discharged, I would say so, but not in connection of acting as an oil overflow.

X-Q. 100. You mean that this float was not homogeneous, that some of it was what you call agitation froth such as seen at the Anaconda or Old Dominion and the rest of it was something else?

A. Yes.

X-Q. 101. Then, under some conditions I take it to be your opinion that the float produced by agitation, an ore pulp containing oil, may consist of partly one kind of a float and partly of another kind of a float?

A. Just consists of the real agitation froth which carries most of the mineral, and then the excess oil may go in there as an emulsion, as it was very evidently on the cell I saw at the Magna. You could separate

this product very easily on a glass placque, that would show very clearly.

X-Q. 102. Then the effect of this excess oil in this instance you are speaking of was not to prevent the formation of the agitation froth such as you saw at Anaconda and Old Dominion, but the effect is merely for the oil to exist alongside of and with the true agitation froth?

A. Well, from my observation of the first cell it seems to break it down and act perhaps detrimentally to that first cell, and this concentrate was very much poorer than it was in the second cell, to the eye.

RE-DIRECT EXAMINATION
BY MR. WILLIAMS:

R-Q. 103. Prof. Fulton, have you any explanation of the agitation froth process?

A. No, I have not.

R-Q. 104. Have your assistants in the Case School of Applied Science made any investigation as to this question of explaining the process?

A. One of my assistants, Mr. Thomas M. Baines made rather extensive investigations in the theory of ore flotation. It is a very attractive subject and one that naturally interests the scientific mind. He being an electrical engineer rather leaned to the electrical theory of flotation, and from what I have seen of his experiment and conversations with him—

MR. KREMER: We object to this as hearsay and and incompetent.

THE COURT: Yes, objection sustained.

MR. WILLIAMS: Exception.

R-Q. 105. Do you accept the adsorption theory as an explanation of flotation?

A. I do not. I do not consider it as a proven theory or as a proven fact. I do not even believe it is a theory. I think it is at present merely an hypothesis.

R-Q. 106. Do you accept the electric theory as an explanation of flotation?

A. I do not. I think the electric theory is a mere hypothesis at the present time.

R-Q. 107. Do you know of any really scientific investigation that has been made on the subject of flotation?

A. Not to my knowledge.

MR. WILLIAMS: That is all.

(WITNESS EXCUSED.)

GEORGE A. CHAPMAN, Recalled, testified as follows:

DIRECT EXAMINATION

BY MR. WILLIAMS:

Q. 1. Mr. Chapman, were you one of the party representing the plaintiff who visited the Magna mill of the Utah Copper Company on April 22nd, during this trial?

A. I was.

George A. Chapman.

Q. 2. And at that plant observed the operations being carried on.

A. I did.

Q. 3. Is this drawing, plaintiff's exhibit 245, a correct flow sheet of the operations as they were conducted?

A. It is.

Q. 4. Please describe what you saw and what your observations were at the time of that visit without attempting to give the full details of the flow sheet, which appear, but giving your observation?

A. I saw the stream entering a classifier said to contain the vanner concentrate from the upper part of the mill being suitably thickened and delivered to the sludge tank, and passing from the sludge tank to this stream was added oil and a solution known as calura. The whole pulp then passed through in one section of the flotation plant through two emulsifiers and 17 double spitzkastens Janney machines. In the other flotation machine there were three emulsifiers and 16 Janney double spitzkasten, double flotation machines. After a conference between Prof. Fulton, Mr. Janney and myself, it was decided to examine the machine with the two emulsifiers only, and also to take samples from one side of the machine for convenience and to save time. This product after passing through the emulsifier and entering the Janney machine—these machines were carrying out the Janney operation of the agitation froth process. High grade concentrates were being recovered from boxes,

George A. Chapman.

2, 3, 4, 5, and 6. From 7 on to 17 a middling product was being recovered with heavier overflow.

THE WITNESS: On the first spitz box practically no ore concentration was being shown. I should consider that first spitz box merely for oil recovery. Any mineral that was caught in this oily float I considered to be mechanically caught there, possibly with slight traces of the agitation froth process, but its one purpose was not really for mineral concentration, but for oil concentration.

The additions of calura were very large, and the first calura addition after the pulp left the sludge tank was by means of a three-quarter inch pipe which was running full stream. Other calura additions were made at various parts of the machine and entered into No. 2 agitator, No. 3, No. 4, No. 5, No. 6, No. 7, No. 8, No. 10, and No. 14. The addition of this calura produced an alkaline condition of the circuit toward the end of the machine, which was more marked as you get toward the end box.

The tailing discharge was in the usual manner, from a spigot from the 17th cell, and the concentrates were delivered to suitable collectors.

Now, the overflow from the first box on the side of the machine that we were examining was very intermittent; I judge that it overflowed perhaps ten minutes in every hour. This intermittent overflow interested me so much that I made several visits to the other side of the machine, and I noticed that of the five visits that I made, it was overflowing on four

George A. Chapman.

occasions; and indeed it would be quite easy, and it would be a great temptation to remove that oily float continuously in ordinary operations.

Q. 5. Did you do anything by way of special examination or separation of the constituents of the float in spitzkasten No. 1?

A. I did.

Q. 6. What did you do, and what did you observe?

A. I placed that oily float on a plaque, and noticed that it could be very easily divided into three products; first, a collection of oil globules, badly broken up with air; second, a sunken oily slime; third, oil globules which sank through the water and could be very easily separated from the settled slime. That separation was even more marked on boxes 2 and 3, where we had more solids to make a comparison. There again we could separate this oily float and could very easily wash off the oil globules which were relatively lighter than the sunken concentrate, and the sunken concentrate had the appearance of the ordinary concentrate that could be vanned from the result of the agitation froth process.

In looking around, it was a great surprise to me that our friends at this plant had not taken advantage of this fact that this oil was so free, and obviously oil costing money, that they had not taken advantage of this simple means of separation to recover a large proportion of their oil.

Q. 7. What was the character of the float as it appeared to the eye on the top of spitzkasten No. 2?

George A. Chapman.

A. Spitzkasten No. 2 produced a typical agitation froth, except that it had an oily appearance, and showed the presence of the golden transparent oil bubbles carrying no mineral.

Q. 8. Now, as to spitzkasten No. 3?

A. Practically the same thing, except I should say the oil was slightly reduced, the free oil.

Q. 9. Spitzkasten No. 4?

A. Spitzkasten No. 4 we were getting to a point when we began to get the typical-looking froth, with still a slight trace of excess of oil.

Q. 10. Spitzkasten No. 5?

A. Well, we could say right down to No. 6 there was a gradual diminution of the oil and a brightening up of the mineral, showing that there was less oil in the later boxes.

Q. 11. And these spitzkasten, 1 to 6, were the spitzkasten that were delivering the finished product?

A. They were delivering the finished product.

Q. 12. Now, spitzkasten No. 7, what did you observe on the surface of that spitzkasten?

A. Spitzkasten No. 7 had a higher water level with a quick removal of the froth, not only assisted by the quantity of water going over, but it was mechanically assisted over by a revolving paddle. It is true that all the boxes had this, except I think it was either 10 or 11, where there was no mechanical paddle, due to the fact that the motor set to drive the shaft for those mechanical froth removers was set at that box. The froth covering over was much lighter in color, and

George A. Chapman.

up to, say, box 12, there were streaks of oil float which could be very easily recognized; particularly on box 10. These streaks were quite apparent and passed over the lip of the spitz boxes in quite separate products. This was so interesting that I asked Mr. Janney, and consulted with Prof. Fulton, that we should examine these streaks, and we took several samples of these, but of course in getting this oil float on top of the ordinary agitation froth, it was difficult to get a sample of this actual float without obtaining a large portion of the light-colored froth. This condition went on to a more or less extent right along in the machine to about the 13th or 14th box, I should say, when these streaks more or less disappeared.

Q. 13. You speak of them as streaks; what proportion of the surface of the spitzkasten was covered by these streaks?

A. On box No. 10 that I particularly examined, I should say 20%.

Q. 14. Did you get a specimen of this streak?

A. I did.

Q. 15. In what box?

A. Box No. 10.

MR. WILLIAMS: I will say that Defendant's Exhibit No. 251 will be accepted in evidence with the same force and effect as if the assayers had appeared and testified.

Q. 16. Now, in defendant's exhibit 251, there appears about a page entitled "Magna Plant Sample No. 8 B, machine No. 1, Spitz No. 10, dark-colored

oily concentrate; assay analysis and oily analysis." Is the material that is described as dark, oily concentrate the same as that you have referred to?

A. It is; it is the sample as collected.

Q. 17. And what does this oil analysis show?

A. It shows that of a total weight of the sample of 28.953 grams, the oil contained was 2.663 grams.

Q. 18. Now, I suppose you compared that with the light-colored froth from Spitz No. 10, which appears on the next page?

A. The total weight of the sample was 19.345 grams, and this contained a total weight of 0.657 grams of oil.

Q. 19. Have you examined the assays and oil analyses set forth in Defendant's Exhibit No. 251?

A. I have casually glanced at them.

Q. 20. Have you looked them through sufficiently to determine what they show as to the various products?

A. I would prefer to have a little more time on that.

Q. 21. Did you also visit the mill of the defendant on April 29th during this trial as a representative of the plaintiff?

A. I did.

Q. 22. Please generally describe what you saw in the way of operations, without giving any further details of the flow sheet than you think necessary to make your explanation clear, having in mind the fact that the flow sheet has already been explained in evidence.

George A. Chapman.

A. The products from the upper part of the mill were made by the ordinary process of water concentration. After being suitably reground and thickened, these products were delivered to a flotation plant. This plant consisted roughly of seven rougher machines and three cleaners, the three cleaners acting in series, not in parallel. There is return products, namely from the fourth, fifth, sixth, and seventh spitzkasten and the various rougher machines, together with the middling product of the first cleaner, the second cleaner and the third cleaner, were returned to the head of the plant and mixed with the crude feed. The first three spitz boxes of the rougher machines were delivered to the first recleaner. The appearance of these first three boxes, particularly the first two, showed the presence of a considerably oily gangue, which gangue could be easily separated from the main portion of the concentrates, by a simple vanning of the products. The middlings overflowed from the rougher machines carried considerable water, or rather circuit liquor, in which was suspended a considerable amount of fine clay gangue. The reagents that were being used were sulphuric acid and copper sulphate solution, which I understand was obtained from Anaconda, and the mixture of oil was said to contain 70% fuel oil, 18% pine oil and 12% kerosene. Mr. Shimmin's later report gives more exact figures for these as follows: Standard Yaryan pine, 24.03%; fuel oil, 64.47%; commercial kerosene, 11.23%. This oil before being added to the flotation circuit was warmed, I judge to be-

tween 40 and 60° C. There were occasions when the oil temperature dropped lower than 40°, but for the major part of the time it was above 40°. The oil addition was being made, at the time of our arrival, at the discharge end of one of the tube mills, but it was perfectly evident by examining the discharge of that same tube mill, that the oil reagent had been added to the feed end of the tube mill, and had been changed over just before our arrival. The first part of the day was spent with Mr. Shimmin and Mr. Hackwood in arranging for various samples to be taken, and check samples for both sides. The sampling proper ~~connected~~ commenced at one o'clock and continued until 5. These samples were taken and gave entire satisfaction to both parties, and should represent fairly well the operations that were being carried on on that afternoon. Three of these samples, the return middlings from the various cleaners, were grab samples, and can only be considered as specimens, but in my opinion they represent the normal running operation of these streams. The only reason why time samples were not taken of the whole of the run was because the streams were very hard to get at and very difficult to sample. I and Mr. Hackwood personally took these samples. One feature of the tailings that is worthy of note: I was fully expecting to find some incipient granules, owing to the fact of the proportion of oil specks that looked like granules, but on close examination proved to be solid oils.

(Recess).

P. 4432, L. 28, after "oil" insert "that was being used, and at first I discovered dark"

George A. Chapman.

Q. 23. What was the condition of the feed to the flotation plant as regards new feed at the time of your inspection of the Butte & Superior—the material in that feed?

A. The new feed was in a pulp of modified water and I examined the upper part of the mill very thoroughly, but could find no additions of oils there so I assumed that the presence of soluble agent was due to return water from either the concentrator thickener or the tailings dam.

Q. 24. What was the dry material composed of—or I presume we can call it the ore that was fed to the flotation plant?

A. It was zinc ore.

Q. 25. Had it any characteristics?

A. Well, the chief characteristic was clearly shown after it had been ground up. It was very evident that there was a large proportion of clay gangue slimes in the pulp, a condition which was rather a surprise to me after knowing the samples of Butte & Superior ore that we had been treating for some time in previous litigation.

Q. 26. What was the result, if you know, of this presence as clay gangue slime in such large quantities in the pulp?

A. Why, this clay gangue slime~~s~~ ~~have~~ has the effect of absorbing the oils and rendering these oils inactive for the functions of the oil flotation process.

Q. 27. And did you observe whether that happened

at what occurred in the Butte & Superior plant when you were there?

A. It was perfectly obvious by the condition of the rougher concentrate and finished concentrate.

Q. 28. Is this matter of oil absorption by the gangue a phenomenon that you are familiar with in flotation operations?

A. Perfectly.

Q. 29. When the oil is absorbed by gangue is it of any use in the process of froth formation?

A. It is absolutely lost to the process.

Q. 30. Did you make any observation as to the amount of return middlings as compared with normal agitation froth process operation?

A. The return of these middlings was much larger than I have ever seen before for two reasons. The first reason was that the middlings overflowed from the rougher machines carried considerable circulating liquor with them; and the other reason having three recleaners. There were three middling streams being returned to the original flotation feed.

Q. 31. I would like you to look at the flow sheet, defendant's exhibit 222, and tell me where the tailings from the three recleaners were returned to?

A. To the feed of No. 1 cleaner.

Q. 32. Then what you have said as to the returns from all of the cleaners going to the head of the plant, if that is what you said is not quite correct?

A. Not quite correct. I am mistaken.

Q. 33. The material returned from No. 3 cleaner to

George A. Chapman.

No. 1 cleaner would go through No. 1 cleaner, No. 2 cleaner and No. 3 cleaner, is that right?

A. The tails from No. 2 cleaner are marked on this sheet "tails to tail race".

Q. 34. Now, is it or is it not true that the material which was returned from No. 3 cleaner to No. 1 cleaner, also the material going to No. 2 cleaner—

A. The tailings from No. 1 cleaner are returned to No. 3, 36 inches elevator, and are returned to the flotation feed.

Q. 35. And what material goes from No. 1 cleaner to No. 2 cleaner?

A. The cleaner concentrate.

Q. 36. What operation did you observe in that part of the plant which has been described as the air cells?

A. Well, I saw there a series of Callow pneumatic cells. They were operating on the tailings from the rougher machines. A low grade concentrate which should be considered as a middling was being produced in these machines and returned to the circuit. My time was pretty well occupied in superintending sampling arrangements and general observations of the plant and I had no opportunity to trace out that product to the upper part of the mill, but I assume that that will be correctly shown on the flow sheet we have just been looking at.

Q. 37. What in your opinion was the process being carried out in the Butte & Superior mill at the time of your visit that you have described ?

A. It was undoubtedly the process of the agitation froth process.

Q. 38. What factors in your opinion contributed to making that process the agitation froth process, in view of the amount of oil that was being fed into the plant?

A. By adding suitable oily reagents to the pulp of finely crushed ore and water and agitating to produce a separation and froth, is what I understand to be the agitation froth process. The admission of these oils may be sometimes of two characters, those that are actually active in the process, and perform the necessary functions, and those that are inactive in the process. I have on many occasions used inactive oils, particularly those like fuel oil, kerosene and stove oil to produce a condition of froth in the spitz box that will maintain a steady condition of overflow. The addition of these reagents in small quantities is extremely useful for ~~the~~ this purpose and considerably eases up the operating work.

Q. 39. Then, as I understand you, such oils as fuel oil and kerosene and stove oil are not active oils in the agitation froth process?

A. Not to my knowledge.

Q. 40. And your knowledge is based upon what?

A. My practical experience since 1905 in the agitation froth process.

Q. 41. Now you spoke of little particles or granules of oil which you saw in some part of the process. What have you to say as to the operation that was indicated by the presence of these little particles of oil?

A. Well, this particular oil passing out with the

George A. Chapman.

tailing to my mind was a demonstration that it was an inactive oil and escaped by that means. There is possibly the same inactive oil in the various froths that were produced in the plant but I couldn't distinguish them in the froth.

Q. 42. You say that this was oil? In what condition was it, liquid?

A. No, it was in the form of little nodules of grease.

Q. 43. And was there any manipulation that in your view would tend to the production of these little nodules of grease?

A. Why, the addition to the plant of an inactive oil. The oil, of course, was delivered to the flotation section warm and sent to the circuit which I should judge to have been on that day between ten and twelve degrees Centigrade and that would certainly cause this particular grease to become solidified although it was a freely running oil when it entered the plant.

Q. 44. About the proportion of the clay gangue in the middlings. Did you see any indication of these?

A. The middling was practically all of this clay gangue.

Q. 45. Have you ever in your experience in the agitation froth process taken any account of the oil returning in the circulating feed in connection with the amount of new oil that you feed to the machine?

A. I never have.

Q. 46. What have you to say about its effect in enriching the feed in mineral contact, as to whether

George A. Chapman.

that is something that you take into account in ordinary agitation froth operation?

A. Yes, in the return of such middlings from the retreatment of concentrates it has always been my aim, and I think it has been generally practiced to allow this return to be about or nearly above the assay of the original feed. If this amount is exceeded you lose the value of flotation feed and thus you are more likely to produce a richer tailing.

Q. 47. That is to say return of mineral in the middling enriches the feed and as a general rule enriching the feed means richer tailings?

A. Means richer tailings.

Q. 48. I would like you to repeat your description of the middlings which were returned in this plant at the Butte & Superior. What did they consist of?

A. The middlings of the plant at the Butte & Superior?

Q. 49. Yes, the middlings returned; what did they consist of?

A. The middlings returned to the feed elevator was the spitzkasten overflow of 4, 5, 6 and 7 boxes.

Q. 50. And did you observe what material overflowed there?

A. Quite light colored froth with quite a large proportion of fine clay gangue suspended in the pulp.

Q. 51. And then that middling return was composed of what?

A. Low grade mineral, some mechanically caught coarse gangue and this fine clay gangue that was returned in the flotation pulp.

George A. Chapman.

Q. 52. I think you said something about the middling consisting entirely of clay gangue. Just what did you mean?

A. Well, the presence of that clay gangue was so striking—perhaps I still have the impression on my mind—but it certainly contained besides the clay gangue some low grade concentrate and as I stated before some mechanically associated coarse gangue.

Q. 53. What is the table that I now show you?

A. This table refers to the visit to the Butte & Superior mill on April 29th of this year.

Q. 54. What are the determinations on this table?

A. The determinations are the assays of the various final products and the amount of oil contained therein.

Q. 55. And these assays and oil determinations were made by whom?

A. Dr. McIlhaney.

MR. WILLIAMS: The sheet referred to is offered in evidence as Plaintiff's Exhibit No. 252, and it is stipulated that that shall be received in evidence with the same force and effect as if the assayer were called and testified.

MR. KREMER: Of course with the right to show any inaccuracy if any should appear in any of these assays as referring to the check samples. I don't think there will be any, but we have not had an opportunity to examine this yet. We will compare it now.

Q. 56. Have you any correction to make to this document as it is here—I note that you have a memorandum on your copy, state what that is.

George A. Chapman.

A. Under the title "Product" there are two products; "concentrate sands" and "tailing sands." These should be called "concentrate sharps" and "tailing sharps."

Q. 57. How would you define a sharp as distinguished from a sand?

A. Why, a sand indicates a gangue product, whereas the term "sharp" would include both concentrate and gangue.

Q. 58. Now, can you give a brief description of this table with the result; take the heading "Dry Waste, Total in Four Hours' Run." That was based on what kind of samples?

A. These are the actual samples taken at the mill.

Q. 59. Automatic time samples?

A. The concentrates and tailings were automatic time samples. The concentrates were deslimed—well, they were mixed with water and allowed to settle one minute, and deslimed and separated into the two products in the proportion which is given in that table. The concentrate sharps— These figures are applied to the total tonnage for the four hours we were there, and sampling, and we have taken the figures given in Mr. Shimmin's report. Now the concentrates are divided, assuming the production of 60.16 tons of concentrate in that four hours, there were 31.37 tons of sharps and 28.79 tons of slimes.

Q. 60. And the figure 60.16 which is here obtained exactly agrees, does it not, with that other figure~~s~~ marked "From B. & S.?"

George A. Chapman.

A. From B. & S. We have taken that figure for that calculation.

Q. 61. Now, is the percentage of heads divided in the same manner?

A. That is divided in the same manner. The tails are divided—there was a total of 203.03 tons, and the tails were divided into 11.4 tons of sharps and 9.97 tons of slimes. The total percentage of these tailings is 77.2% of crude ore treated. This 77.2% was divided into 42.3% of shares and 34.9% of slimes. These next products were assayed separately as follows: Concentrate sharps assayed 46.9% of zinc; concentrate slimes assayed 41.8% of zinc; a composite assay of the two was 44.5% of zinc.

Q. 62. And the Butte & Superior figure is 45.2?

A. 45.2. That is within reasonable limits of assaying and sampling errors.

Q. 63. Continue.

A. Of the tailings, the sharps assayed 1.49% of zinc and the slimes 1.91% of zinc and a composite assay of these products was 1.68, against 1.57% of zinc from the Butte & Superior assays, which is within reasonable limits. The calculated assay from those various products of heads was 11.44% of zinc against 11.53% of zinc, Butte & Superior assays, which is again within reasonable limits. Now, the recovery of the zinc in the concentrates on these figures is shown in 88.7% zinc against the figures of the Butte & Superior Company of 89.5, which is within reasonable limits. Now, this recovery, of this 88.7 recovery,

George A. Chapman.

48.8% recovery was in the sharp portion of the concentrate and 39.9 in the slime portion. Of the 11.3% lost in the tailings, 5.5% was lost in the sharps and 5.8% in the fines. Now these products, the oil determinations were made on them with the following results: The concentrate sharps carried 22.8 lbs. of oil per ton; the concentrate slimes carried 93.4 lbs. per ton. A composite figure derived from these two is 56.6 lbs. per ton of the total concentrates, against 62.6 lbs. per ton Butte & Superior figures. The oil determinations of the tailings showed 14. lbs. per ton of oil which could be divided into the sharp tailings of 0.296% of oil and in the tailing slimes, 30.6% of oil. The next column, the percentage of total oil to feed is as follows: 50% of the total oil used was recovered on the concentrate; 10.5% of which was on the sharp portion of the concentrate and 39.5% on the slime portion. 41.7% of the total oil was determined to be on the tailings, of which 0.5% was on the sharp portion and 41.3 on the slime portion. Now, the total oil recovered has been divided into two portions; on the sharp portion of the concentrate there was 10.6 per ton.

Q. 64. Of what kind of oils?

A. Volatile oil.

Q. 65. Do you know, as a matter of fact, that that was a natural division in the work of oil determination?

A. Well, I am not qualified really to go into the chemistry of oil, and I accept these figures as given by

George A. Chapman.

Dr. McIlhaney, and if there is any explanation to make, I think he can make it. 10.6 lbs. per ton of volatile oils on the concentrate sharps; 42.9 per ton on the concentrate slimes; the composite figure for these two is equivalent to 29.1 lbs. of volatile oil on the total concentrates recovered. Tailing sharps contained 0.172 lbs. per ton of volatile oil and 16.2 lbs. of volatile oil on the slimes. The composite figure on the total figure is 4.7 lbs. per ton of volatile oil. The percentage of the division of these volatile oils recovered in the various products is as follows: In the concentrate sharps it is 12.29%; concentrate slimes, 52.34%, making a total on the concentrates of 64.63%. For the tailing sharps, 0.71%; for the tailings slimes, 34.66%, making a total for the tailings of 35.37%. Of the non-volatile oils that ~~was~~ were contained by the concentrate sharps, 12.2 lbs. per ton; concentrate slimes 44.2 lbs. per ton, and total concentrate, 27.5 lbs. per ton. On the tailing sharps, 1.124 lbs. per ton.

Q. 66. 0.124 I have it.

A. My copy gives it 1.124.

MR. WILLIAMS: We will put that in as 1.124 at present, and we will check it up.

A. The tailing slimes, 20.4 lbs. per ton. The total tailings, 9.3 lbs. per ton. The percentage of the non-volatile oils represented by these various products is as follows: Concentrate sharps, 10.8%; concentrate slime, 35.89%; total, 46.69%. The tailing sharps, 0.39%. Tailing slimes, 52.92%. Total tailings 53.31%.

Q. 67. Now, as to the lower figures of these col-

umns, you did not give them all; the amounts of oil, did they check up?

A. No, there is a loss. Of the total oil, 91.7% is shown to be on these various products, and that checks very closely with the Butte & Superior figure of 93.4%.

Q. 68. And the difference between that and 100 is the loss in the determinations?

A. The loss in the determinations, yes.

Q. 69. Do you know of any particular circumstance that would contribute to the fact that the loss was 8.3% in one instance and 6.6% in the other instance; if you do not know you may just answer that you don't.

A. Well, it is possible that the determinations made by Dr. McIlhiney include both volatile and non-volatile oils, while those of the Butte & Superior are of the total oils, and that was totaling the amount of the determinations, and it might possibly account for that slight difference.

Q. 70. You think the loss of the oil in solution in the water of the pulp, would that contribute to the failure to account for the total amount of oil in the product?

A. If I understood Dr. McIlh~~a~~iney correctly, he took all the water with the product.

Q. 71. So that any soluble frothing agent would have appeared in the calculations?

A. Yes.

THE COURT: Are you asking the witness to account for the difference between the two assays?

George A. Chapman.

MR. WILLIAMS: No, the difference from 100.

THE COURT: He answered as to the discrepancy between the two assays, as I understood it.

THE WITNESS: I did in my first answer, yes, sir.

MR. WILLIAMS: Q. Is it or is it not to be expected that in an operation of this kind with considerable quantities of oil divided up into separate products, that the oil determinations will account ~~of~~ for all of the oil?

A. Well, it is practically impossible.

Q. 72. Now, was there any characteristic of this process as carried on by the Butte & Superior in regard to agitation that was different from the normal agitation froth operations that you are familiar with?

A. I should say the agitation was greatly increased over the standard Mineral Separation practice.

Q. 73. THE COURT: What effect would that have, or has it any that you know of?

A. Why, it would have the effect of beating these inactive oils against air bubbles, and possibly be carried to the surface on air bubbles. We used to have the same effect with the Cattermole process, where some of the granules by agitation were broken and would become attached to one single air bubble, and would be carried practically to the surface, and then the bubble would break and the broken granules would fall in the form of a flock, and I think it is quite possible that this very violent agitation would cause a partial—well, a very fine subdivision of these inac-

tive oils, and allow them to be caught with air bubbles and taken over with the flowing froth.

Q. 74. MR. WILLIAMS: Returning now to the Utah Copper Company inspection, have you a table of the results of analysis and deter—and examination of the samples obtained?

A. Yes, sir.

MR. WILLIAMS: I offer in evidence this table. as plaintiff's exhibit No. 253, with the same stipulation as the last and same exception.

MR. KREMER: I don't think there will be any occasion for that; it may be admitted.

Exhibit No. 253 admitted.

Q. 75. Now, what does this table show?

A. That the assay of the flotation feed was 7.4% copper. The concentrates recovered were 26.3% copper and the tailings rejected were 0.2% copper. The indicated recovery, by the well known formula, is 97.9% recovery. The oil on the concentrates and tailings was estimated as follows: The total oil on the concentrate was 2.81%; total oil on the tailings was 0.199%.

Q. 76. And this is divided up between the volatile and non-volatile?

A. Yes—The volatile oil on the concentrate—

Q. 77. You need not give those figures. Now as to the recovery of oil fed, 1.06%, or 21.15 lbs. per ton, what did you find there?

A. That 73.1% was associated with the concen-

George A. Chapman.

trates and 13.6 was associated with the tailings, making a total of 86.7%, meaning a loss of 13.3%; but I should not like to say that that is due to any error in the assaying, for it must be understood that we had only four hours to sample this particular run, and our samples partook more of the nature of specimens rather than time samples, so it is quite possible that that error or most of it can be accounted for in that way.

Q. 78. Now, you have here the skimmings of the first spitzkasten, with a total oil of 26.24%. Is that the float that you described as appearing in the first spitzkasten?

A. It is.

Q. 79. And the next two, concentrate from second spitzkasten, with a total oil figure of 4.87%, that is the amount of oil that was found in that second spitzkasten?

A. It is.

Q. 80. Now, have you examined the determinations made in behalf of the Utah Copper Company, exhibit No. 251?

A. I have.

Q. 81. Having before you all of these determinations, and having seen the plant in operation, I wish you would say what process was being carried on at the Utah Copper Company on the occasion of your visit?

A. The process employed at the time of our visit was undoubtedly that of the agitation froth process.

The incident of that oil removal at the first spitz box, not being one of ore concentration, I would exclude that one box; but the rest of the plant was undoubtedly the agitation froth process.

Q. 82. Did you observe whether or not the oil fed to the plant was fed in a heated condition?

A. It was, at a temperature of 62° C.

Q. 83. And was the pulp heated or not?

A. The pulp was normal temperature.

Q. 84. About what was it on that day?

A. Ten to fifteen degrees Centigrade. There may have been just a little heat or raise in temperature by reason of the fact that the pulp was kept in suspension in the sludge tank by means of a small jet of steam—or perhaps that was compressed air; I will have to look at my notes. I will withdraw that last statement: it was compressed air.

Q. 85. It was suspended by compressed air and not steam?

A. Compressed air, that is all.

Q. 86. But there was no heating in the plant except to the oil?

A. The oil and the calura.

Q. 87. Now, you have testified, and other witnesses have testified repeatedly about the standard machines of Minerals Separation Limited. I show you the drawings in the Hyde Record, entitled "Plaintiff's Exhibit, King John's Court, Standard Plant," appearing on pages 1027, 1030 and 1031, and I might note that the evidence shows that this plant was in

George A. Chapman.

operation in the laboratory in King John's Court in the latter part of the year 1910. Now, I ask you how that flotation apparatus or machine appears to you to compare with what you have referred and the other witnesses have referred to as the Minerals Separation standard plant?

A. These drawings practically represent the standard machine of today, with the exception that the pipe C on the sheet has been replaced by a curved pipe, to do away with the right angle turn, which causes unnecessary wear and chokes up at times. The baffle F, has been reversed.

Q. 88. That is, instead of pointing up it now points down?

A. It points down.

Q. 89. Those are all the changes that have been made in the last seven years?

A. That is all. Those machines also appear to be belt driven, but most of the modern machines are gear driven.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 90. Mr. Chapman, if the first cell at the Magna plant had been overflowing and discharging float regularly, would that have altered your answer in which you stated you considered that the process that you saw at Magna was the agitation froth process?

A. If that float had been removed continuously,

that box, which is merely acting as an oil remover and not as a cencentrator at all—

X-Q. 91. Well, would you consider that the process carried out there was that of the agitation froth process?

A. You mean the machine as a whole?

X-Q. 92. Yes.

A. Certainly.

X-Q. 93. And if you make any distinction, what would you say about that first box?

A. That first box was merely there to prepare the pulp for the final successful treatment by the agitation froth process.

X-Q. 94. How about the first box in the Butte & Superior installation. Considering it separately as you have considered the one at Utah separately, was that box being used for the agitation froth process?

A. Yes, it was, but in this instance I can say that if you had removed the clay gangue from the Butte & Superior feed, that you would have had exactly the same condition as what you had in the Magna first box.

X-Q. 95. Do you think that the quantity of oil necessary to treat an ore is related to the character of the gangue?

A. In many instances, yes.

X-Q. 96. So that in your opinion the ore having some classes of gangue would require more oil than a similar ore with a different character of gangue?

A. Yes.

George A. Chapman.

X-Q. 97. Now I don't know whether you know how Dr. McIlhaney got this determination of the oil on the sharps as distinguished from the oil on the slimes, but if you do I would like to have you answer this question, as to whether, after allowing the pulp of the concentrate to settle for a minute, and then floating off the slimes—whether that did not carry with the slimes all of the detached oil in the mixture?

A. I did not see the operation performed. I will leave that to Dr. McIlhaney.

X-Q. 98. You did not know the conditions?

A. No.

X-Q. 99. I think from what you have said that you can answer this question: Did you or your associates sample or analyze the flowing pulp with the suspended clay gangue separately for oil in the middlings?

A. I don't think those figures are mentioned here, Mr. Scott, and if they are not on this sheet I am afraid that they have not been done.

X-Q. 100. I am referring to the middlings.

A. The middlings returned?

X-Q. 101. Yes.

A. No, I am afraid they have not been done.

X-Q. 102. Then you have no definite data upon which to base the statement that a large amount of that oil was absorbed in and adhering to these clay slimes, have you?

A. I have no definite data, except that one little point on the flow sheet just now, which convinces

me that my opinion is right. If you want me to go into that point I will explain it to you.

X-Q. 103. You may do so if you wish?

A. In describing the returns of these various middling products just now I made the mistake of saying that they were returned to the head of the flotation machine and overlooked the point of these middlings from No. 2 cleaner being sent to the tail race. I was very much surprised and at first I said that was a mistake on the flow sheet, but withdrew the statement. In the whole of my flotation experience I think it is the only example of which I know and have heard of where a middling product from the cleaner is discarded to the tail race. Now, it is perfectly obvious that the only reason for doing that is that the amount of this oily clayey gangue is built up to such an extent in the circuit that it is necessary to discard that portion of that at that point rather than let it go back into the various machines and produce a much lower grade concentrate.

X-Q. 104. Did you, Mr. Chapman, see any of this clayey gangue carrying oil with it?

A. I observed some, yes.

X-Q. 105. At what point?

A. In these various middlings returned. This clay gangue, if you shake it up in water, gives a peculiar streaky color to it, and the presence of oil is certainly shown by the excess of these streaks over the ordinary pulp appearance.

George A. Chapman.

X-Q. 106. Did you make any examination that enables you to say that this clay gangue carries a greater relative proportion of oil, that is relative to the concentrate, than any other kind of gangue?

A. The only thing I can refer you to is these sheets that have been put in evidence which show there is a marked difference shown between the tailing sharp and the tailing slimes.

X-Q. 107. But you don't know how that determination was made, that question I just asked you about flotation over the slimes and whether that wouldn't carry with it all the detached oil and clay with the slimes?

A. Dr. McIlhiny who did these determinations—I have known this gentleman for some time and I know if he did a thing like that he would certainly mention it to me.

X-Q. 108. Are we quite clear about that now? As I understand it there is no flow back to the head of the machine except the tailings from the No. 1 cleaner and the middlings from the lower cells of the rougher machine? That is correct, isn't it?

A. Yes.

X-Q. 109. Now, you have explained the operations at the Butte & Superior which you saw by reference to the clayey gangue slimes, you referred to. Is it your opinion that it would not be possible to practice the process with as large an amount of oil if that clayey gangue slime were absent?

George A. Chapman.

A. You could practice the process if you followed out the process of the Magna mill.

X-Q. 110. Well, suppose we simply eliminate the criticism you make of the Magna mill and carry it out just the way they did at the Butte & Superior mill. Do you think that it would be impossible without the presence of this clay gangue slime you refer to?

A. I should think it would be quite possible to carry out the process, yes.

X-Q. 111. With the same amount of oil?

A. Yes, with the same amount of oil.

X-Q. 112. And the same procedure?

A. Yes, the same procedure.

X-Q. 113. And in the absence of the clay gangue?

A. In the absence of the clay gangue, yes.

X-Q. 114. And it still would be the agitation froth process?

A. Absolutely.

X-Q. 115. I don't suppose you know how Dr. McIlhiney drew the line between the volatile and non-volatile oils that are shown upon exhibit 252?

A. I would prefer to let him describe it, Mr, Scott.

MR. WILLIAMS: We will put Dr. McIlhiney on the stand.

X-Q. 116. MR. SCOTT: Now, referring to exhibit 253, which is plaintiff's exhibit representing the results at the Magna mill during the visit of plaintiff's representatives, will you state whether you think the recovery there shown 97.9 per cent of the copper is a good result, metallurgically speaking?

George A. Chapman.

A. It is a very good result.

X-Q. 117. You have stated that if the Butte & Superior Company were to carry out the process just the same as you saw it on that Sunday of the visit and we were to eliminate the clay gangue slime that that would be the agitation froth process. Do you place any limit at all as to the amount of oil in what would be the agitation froth process?

A. I limit the amount of active oils to what is the agitation froth process.

X-Q. 118. And to what do you limit it?

A. Why, the point of maximum efficiency.

X-Q. 119. You cannot say, can you, Mr. Chapman, that upon the occasion of your visit to the Butte & Superior mill no kerosene or fuel oil coated any of the bubbles or any of the mineral particles, can you?

A. I can't say that, no.

MR. SCOTT: That will be all.

THE COURT: Just point out to me on this flow sheet, exhibit 222, where the concentrates went, those to the cleaners?

A. If you take the specific example shown on this flow sheet, namely No. 1 pyramid, the concentrates are drawn from the first, second and third spitzes on each side and join together and pass through No. 16.

Q. 120. MR. WILLIAMS: Is that an elevator?

A. I assume that is an elevator. And they continue to a point marked 19 and from there enter No. 1 cleaner in the cell marked No. 5. That is true of all

these rougher machines. Now, the concentrates recovered from the first cleaner pass down and pass through pump 23 and from 23 go into cell No. 1 of No. 2 cleaner. The first three boxes of No. 2 cleaner discharge a concentrate which passes to an elevator, No. 17, and from there through No. 20, to the spitzkasten marked No. 5 of No. 3 cleaner. The concentrates from No. 3 cleaner pass and are considered as finished concentrates and are thickened. The tailings from No. 1 cleaner pass~~es~~ to a 36-inch elevator and through junction boxes into the sludge tank and back as shown to the original flotation feed. The tailings from No. 2 cleaner are discharged direct to the tailings race, and leave the circuit at that point. The tailings from No. 3 cleaner pass to elevator No. 16 through No. 19 and back as shown to the feed to the No. 1 cleaner.

Q. 121. THE COURT: The tailings from No. 3?

A. The tailings from No. 3, yes, that is right. The tailings from these various cleaners are considered as middling.

Q. 122. Speaking of this No. 1 cell on the spitz box at the Magna plant, about which you have testified, you say your theory is that this No. 1 box serves as an oil remover. Where does that oil go?

A. That is joined to the main stream of concentrates.

Q. 123. Well, but I understood you to say it wasn't overflowing to any particular extent?

George A. Chapman.

A. Well, the day we were working it was overflowing intermittently, about ten minutes every hour, and the other side, which was a part of the same machine, in the five visits I made to it was overflowing on four occasions, and this overflow joined the main concentrate stream and was distinctly different in color.

THE COURT: Any further questions by either of you of this witness.

RE-DIRECT EXAMINATION,

BY MR. WILLIAMS:

R-Q. 124. I don't know, Mr. Chapman, that I exactly understood your testimony in regard to the limitations of the agitation froth process to the point of maximum efficiency. That is the way I heard it?

A. Yes.

R-Q. 125. Tell me just what you meant?

A. Well, it is usual in flotation operations to make additions of reagents to give you the best results, and a property—particularly the large properties where the feeds are very constant—this point of best results or as I have termed it before maximum efficiency, is maintained very steadily. There are occasions when something may happen in various parts of the mill that a portion of the feed is turned off or increased, and then comes a time when this condition of maximum efficiency is disturbed. It is then, if your feed is increased and before we have time to increase the reagent, you find that the result is detrimental and the

recovery suffers until you re-establish the proportion of reagent feed to what was the best condition before.

R-Q. 126. And if, on the other hand, your oil supply diminishes?

A. Well, the process suffers again.

R-Q. 127. And that is the point of maximum efficiency, is that right?

A. It is, yes, sir.

WITNESS EXCUSED.

WHEREUPON an adjournment was taken until 10:00 a. m. tomorrow, Friday, May 11th, 1917.

Friday, May 11th, 1917, 10 a. m.

ARTHUR HOWARD HIGGINS, a witness called in rebuttal on behalf of the plaintiff, testified as follows:

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 1. Please state your name, residence, age and occupation.

A. Arthur Howard Higgins; age 36; residence London; occupation metallurgist.

Q. 2. Please state your education and qualifications as a metallurgist, with special reference to the froth flotation process.

A. I received my education at the Bradford Technical College, followed by a course at the Royal School of Mines, where I graduated in 1901; in 1902 I was

Arthur Howard Higgins.

assistant demonstrator in mineralogy and geology. At the end of 1903 I joined the Minerals Separation Company's staff.

Q. 3. How long have you been engaged in the study of the air froth flotation process?

A. I have been engaged in the study of the air froth flotation process since its discovery in 1905.

Q. 4. And what has been the nature of your work during that period of 12 years?

A. Chiefly in the development and improvement of the air froth flotation process; largely in the laboratory and occasionally in the mill.

Q. 5. You made an estimate when testifying in the Miami suit that you performed about 20,000 operations under the process of the patent here in suit. Do you accept that as a fair average of those operations up to two years ago?

A. Yes, I do.

Q. 6. Since that time have you continued your study of operations in regard to this process?

A. I have.

Q. 7. And, as I understand you, for the past twelve years you have been continuously engaged in the study of this process? Is that right?

A. Yes, that is correct.

Q. 8. Have you studied and are you familiar with the Everson patent No. 348,157, of August 24, 1886?

A. Yes, I have studied that patent and have been familiar with it for some time.

Q. 9. You might tell us when your attention was first called to it and under what circumstances.

Arthur Howard Higgins.

A. My attention was first called to this patent about the end of 1904 when Mr. Sulman brought the specification into the laboratory and we discussed it together and then he asked me to make a repetition of the example on page 2.

Q. 10. Known as the Everson, what method?

A. The Everson first method. The operation was carried out according to the details she gives in the specification and we got a successful result.

Q. 11. Since that experiment carried out by you in 1904 have you repeated the operations of this first method? And if so, about how many times?

A. I have repeated that ~~operations~~ operation since then a good many times; I think somewhere between fifty and one hundred.

Q. 12. Is there any characteristic about that operation as to whether you fail or succeed?

A. Yes, but I don't know what exactly that characteristic is. Some detail in making the compound of the oil, and acid, which is not given in the description; for the success or failure of the operation seems to be a mere matter of accident, whether one gets a good result or a bad one.

Q. 13. Well, about how many times have you succeeded and how many times failed?

A. I suppose in fifty times I have succeeded about twenty and failed thirty.

Q. 14. When you carried out this operation in 1904 what apparatus did you use and what instrumentalities?

Arthur Howard Higgins.

A. For mixing the compound, we had an evaporating dish, spatula, barrettes and things of that kind, and for the washing out operation we used an ordinary hand basin containing water, squeezed the pasty or plastic mass through the hands so as to open it out in the manner in which she suggests.

Q. 15. And is that or is that not the mode of operation described in the specifications?

A. Yes, that is the mode described.

Q. 16. In that operation do you ~~put~~ first produce the "stiff mass" referred to on page 2, line 36, of the specification?

A. Yes, one always gets the stiff mass; that is very easy. The difficulty in the process in the cases where it fails is where the stiff mass does not remain sufficiently plastic in the water so that we cannot get the pasty mass or lump or lumps that she refers to in lines 65 to 68 in the specification.

Q. 17. Now, there is a statement in the specification as follows: "In treating so small a bulk as above specified, the mass may be squeezed repeatedly in the hand in a basin of water, the substance, so manipulated being expressed between the fingers each time it is squeezed, and thus made to expose new surfaces to the water, from which the sand will be detached so as to fall to the bottom of the basin." That is the description, is it not?

A. That is the description.

Q. 18. Now, following that is the statement in line 60: "In practice upon large masses, any vessel having

an outlet or outlets at its bottom for the escape of the water and sand will be suitable for this operation of washing, and mechanical means will, of course, be employed to break up the mass. The concentrated material will accumulate in a pasty mass or lump or lumps and will contain the metallic portion of the ore, together with the hydrated oil and acid, which oil may be removed by heating and afterwards roasting or by other suitable means." What have you to say as to that part of the specification, referring to the operation on large masses through the employment of mechanical means to break up the mass and the recovery of concentrate in a pasty mass or lump or lumps?

A. This portion is what one might call a method of unkneading the stiff mass which we previously obtained, but I know of no machinery—I could not find any machinery which I thought would be suitable for that purpose. It is not exactly like the ordinary kneading operation, in which dough is made, and for which dough making machinery is particularly applicable. It is the reverse of this; one has to open the mass so the interior is coming out constantly to the exterior, to give the sand a chance to become detached. The condition of the concentrated mass I read as applying to the whole of that method; it is not applied only on a large scale; it is applied just as much in this laboratory example.

Q. 19. Have you made any study of the literature for the purpose of trying to find if there was any apparatus disclosed and known at that time capable of this use?

Arthur Howard Higgins.

A. Yes, I have made that examination, and the only thing that I found were pug mills and mortar mixers such as Haynes used, and those are not satisfactory for this purpose.

Q. 20. It has been stated in the testimony for the defendant that this Everson patent discloses the conjoint use of sulphuric acid and sulphate of copper. What have you to say as to that?

A. I find no disclosure of the conjoint use of any acid and salts or acid and acid salts. The disclosure is of an acid or of a salt; there is no disclosure of copper sulphate or copper chloride being used in connection with acid or in combination with acid.

Q. 21. What is an acid salt?

A. It is a salt in which the hydrogen is only partially displaced by the metal; a common example would be the acid sodium sulphate.

Q. 22. That is, it is a compound which may be said to consist of sulphuric acid and sodium sulphate combined together in one compound, so that it is partly salt and partly acid, is that right?

A. Yes, that is true.

Q. 23. In the description of the Everson patent what reference do you find as to the applicability of the process to an ore containing clay?

A. The specification is very explicit on that, beginning line 29, page 1. It says: "The invention is more specially applicable to the treatment of ores in which the metal or metallic portion is mixed with quartz or other rock, as distinguished from mineral mixed with

Arthur Howard Higgins.

slay; though it is applicable to ores containing alumina together with quartz or other rock, to the extent of permitting the removal of the silica or sand." The silica or sand of course is quartz. The specification in a good many places refers to the removal of this quartz rocky gangue. There are 12 references to the gangue in this specification, in all of which she refers to the gangue as quartz or rocky gangue.

Q. 24. Now, as to the Everson second method, have you tried to carry it out a number of times?

A. Yes, I have.

Q. 25. How did you try to carry it out at first?

A. In the first trials of this method we tried to carry this out with an agitator to thoroughly detach the sand from the mixture, followed by a spitzkasten to attempt the separation of the concentrates, under the impression that the process was more or less a reversal of the Cattermole procedure.

Q. 26. And in what manner was the spitzkasten used?

A. One might say that one uses the spitzkasten upside down, instead of taking the concentrate off at the bottom, we took the concentrate off at the overflow and we removed the sand at the bottom.

Q. 27. And did you have any success in that kind of an operation?

A. None at all.

Q. 28. There are operations described in the Hyde record, one of them in which the so-called concentrate contained less mineral than the original ore and the

Arthur Howard Higgins.

so-called tailings contained more mineral than the original ore; is that a fair example of what you got?

A. Yes, that is a fair example.

Q. 29. And when, and under what conditions did you attain a reasonably successful operation in the concentiation of ores in accordance with this second method of Everson?

A. In the use of this spitzkasten or classifier to separate the material, it became evident that the thing was not useful for that purpose, and, referring to the use of the spitzkasten in the art at that time, it was quite evident that that spitzkasten in the wet concentration of ore was never used for the separation of mineral and sand. By following that line of reasoning we came to the conclusion that—Dr. Liebmann and I were studying the proces at that time together—that the proper method to use was to adopt the same separating device that they used, that is, the shaking or bumping table, or the vanner, and on the table we have the constant overflow of water which carries away the lighter portions of material that is fed into it and the heavier portions coming off the end of the table. For that reason we took the batea, which is one of the laboratory instruments which reproduces the action of the bumping, shaking or vanning tables.

Q. 30. And the batea also happens to be what sort of an appliance in the art?

A. That is a washing out vessel which is frequently used for the separation of gold from auriferous sands.

Arthur Howard Higgins.

Q. 31. Did you discover any coincidence between the proportions disclosed in the Everson specifications and the contents of a standard batea?

A. Yes, the quantity of ore which she states as being abundantly moistened by the three fluid drams of oil is two ounces; and this two ounces is a very satisfactory quantity to handle in a batea, so the method appears to me to be suitably carried out and I think properly interpreted by the use of a batea.

Q. 32. And when the batea is used and the material is flowed over to the edge of the batea is it or is it not a fairly successful metallurgical operation?

A. Yes, it is a fairly successful operation.

Q. 33. Recoveries having been about what, in the experiments that you have made?

A. I think I had the recovery as high as 80%.

Q. 34. Now, I will ask you to perform, first an experiment using the batea with ore and no oil, just ore and the water. Under those conditions what would happen?

A. One gets the lighter material carried away from the heavier material, it flows off in the water.

Q. 35. And the lighter material is what?

A. The lighter material being the sand.

Q. 36. Now, when you use the oil in the proportions disclosed by Mrs. Everson, what then happens?

A. Then you get exactly what she tells you you will get, the transposition of the mineral and the oil with the sand; that is to say, the mineral and oil become

Arthur Howard Higgins.

lighter than the sand and they are washed off with the water in the same position as the sand was previously washed off.

Q. 37. I read you the language of the specification, commencing on page 2, line 108: "Bearing in mind that the sand and mineral are merely transposed, or their relative positions are reversed, because the sand is heavier than the mixture of mineral, oil, and acid." Please state whether that is a description of what takes place.

A. That is an exact description of what one finds.

Q. 38. Now, will you carry out the operation without the oil and then show us the reversal of that operation with the oil; you may describe what you are going to do now.

A. In the first operation I am going to take 57 grams, that is, two ounces, of the -35 mesh feed to the Wilfley table from the Anaconda plant. The reason that I have had the plus 35 mesh sifted out from this material is that it is too coarse to handle on the batea.

Q. 39. And this material that you are taking is the feed to the shaking table, is it?

A. Yes, feed to the shaking table.

Q. 40. The operation that you will perform will represent the operation of a shaking table? Is that right?

A. Yes, it will.

Witness performs the operation.

A. These are the concentrates resulting from the vanning operation.

THE COURT: Of course that is simply an experiment; not what is in the patent.

MR. WILLIAMS: This shows the ordinary operation which the patent reverses.

Q. 41. THE COURT: This is what?

A. That is the ordinary operation in which the sand is overflowed and the mineral remains in the vessel.

MR. WILLIAMS: Now, if you wish to cross-examine, Mr. Scott.

CROSS-EXAMINATION.

BY MR. SCOTT:

X-Q. 42. Is the procedure which you just carried out, the batea, so far as manipulation goes, the procedure which you construe as being described by the words in the Everson patent, "a constant overflow of water?"

A. Yes. As I understand the "constant overflow of water" is the overflow of water which occurs on the side of the bumping or shaking or vanning table. The batea is not operated in exactly the same manner. Usually one does not have an assistant to keep a flow of water running over the batea the whole time. The operation is generally carried out by dipping the batea into the dish or the lake or whatever you have to wash with, and it overflows intermittently.

The same sort of an operation as produced on this batea can be produced on a Wilfley table, and this is done in thousands of instances in examining any kind of

P. 4469, L. 23, after " operations " insert " what she thinks ought to be used in large scale operations,"

Arthur Howard Higgins.

a prospect. I am convinced that the batea does represent the vanning table, bumping or shaking table.

X-Q. 43. The flow of water from the batea as you represent it was merely an intermittent flowing off or slopping off of the water, was it not, as you did it?

A. The flow stopped occasionally, yes; that is true. That does not alter the operation of the process in any way.

X-Q. 44. You consider that the manipulation you just carried out meets the words "a constant overflow of water" as well as a settling box or spitzkasten with a current of water coming in at the bottom and overflowing at the top constantly, as stated in the patent?

A. The device that she refers to "devices and methods now well known" and the apparatus that she requires is not the specification of the apparatus that she tells you to use in the laboratory experiments. She finishes, in the paragraph before, with regard to the laboratory experiments. She leaves you to carry that out in a way which every metallurgist would be able to find out easily. The constant overflow refers to the large scale operations, or such vanning, shaking and bumping tables as were then in existence.

X-Q. 45. What is there in this patent that leads you to think that a constant overflow of water referred to something like a batea rather than a spitz box with a really constant overflow of water coming in at the bottom and going out at the top?

A. First of all you have to consider the fact that

she says, "the mineral and the sand are transposed." Now, to start with you must transpose them back again to their original position, with the sand lighter than the mineral. Now, the devices which you take for that separation are not spitzkastens or classifiers. They had never been used in the art for separating mineral and sand. The devices which are used are the shaking table and the bumping table and the vanner, and for very coarse stuff, one uses jigs. So, when you come to the transposition, there is no reason whatever why you should not take the same transposed stuff and treat it on the same apparatus.

X-Q. 46. How about the separation of the heavy material from the light material in the upcast of the Cattermole process; isn't that an instance?

A. That was an instance where an upcast was used very much later than the Everson specification; it was not used for that purpose before the Cattermole patent was published.

X-Q. 47. What is a spitzkasten used for except to separate lighter or finer material from coarser and heavier material?

A. It does not separate light or coarse material from heavier or finer; the spitzkasten separates material according to its falling power in water. If we take galena and sand and grind them up together and put them in water and mix them, and then classify the pulp, it will separate according to its falling power in water; you do not get any separation of galena from the quartz; ~~you~~

Arthur Howard Higgins.

~~do not get any separation of galena from the quartz~~; in one box of the classifier you would probably get very light sand mixed up with some much finer galena, and as you go down you would find that in each case you have got a mixture of quartz and galena, the only difference being their actual size.

X-Q. 48. How about the patent in suit? It shows spitz boxes with upcasts in the water for the purpose there stated of carrying upwards the float or froth and sinking the finer slimes in one spitz and the coarser slimes in another and the sands in another?

A. The patent in suit is dealing with something that was not known at the time of the Everson specification, and I have referred to the use of these pieces of apparatus at the time of the Everson specification.

X-Q. 49. And you base your use of the batea simply on your assumption that the Everson process resulted in something different from the patent in suit, and proceeding on that assumption you proceed with this program of experiments?

A. That is not an assumption; that is what I find from a study of these specifications.

X-Q. 50. It is your conclusion?

A. It is my conclusion, and I think I have support from the fact that I can get results from the batea when I cannot get them from the spitzkasten.

~~X~~-Q. 51. MR. WILLIAMS: You were asked about the use of the spitzkasten in the days of the Everson patent, and you did not tell us what the overflow

from the spitzkasten was in the days of the Everson patent?

A. In the days of the Everson patent the overflow from the spitzkasten was a large amount of water carrying a good deal of slimy material, both mineral and gangue. In those days it went to waste.

Q. 52. And it was known as what sort of a device in mineralogy?

A. Simply a classifying device, to obtain material suitable to be treated in what we call hindered settling operations; that is, the operations that are carried out in jigs, bumping tables and shaking tables.

Q. 53. And in the days of the Everson specification was there an upcast classifier resembling in its construction the Cattermole upcast?

A. No; in those days the classifiers differed somewhat. They all opened outward as they went up to the upper part, so that you got a different flow of water in every part of the vessel; the overflow being greatest at the bottom and decreasing gradually toward the top of the vessel. Otherwise the principle was the same.

Q. 54. Now, just one thing more. In that operation which you carried out in the batea did you or did you not exactly reproduce what the gold miner does in panning his sands?

A. The gold miner does it exactly in the same way.

Q. 55. And where does he find his nuggets?

A. He finds the nuggets in the tip of the hollow.

Q. 56. That is, in the pan after he has washed them out?

Arthur Howard Higgins.

A. After he has washed out the sand. The sand goes away from his body, and the gold remains on that part of the pan that is nearest to his body.

Q. 57. Now, I will ask you to carry out the Everson second method in a batea, and first, before you start, tell us what you will do?

A. I shall take a small quantity of the same ore, that is minus 35 mesh of the Wilfley table feeds at the Anaconda plant, and mix that with 11 c.c. of engine oil, which is 17 per cent of oil to the ore; and having mixed them together, I shall agitate the mixture in acidified water, which has point two per cent of sulphuric acid; and having agitated thoroughly, transfer it to a batea, and wash it in the same manner that I washed the ore without any oil.

(Mixing ore and oil.)

That is, I have mixed the oil with the ore and made a moistened mass.

Q. 58. State whether or not you have thoroughly mixed them?

A. Yes, I have thoroughly mixed them. Now, I have added to that some acidulated water, and with the assistance of the water I will carry out the washing process. Now, I am agitating the moistened mass so as to mix it with the acid water.

Q. 59. You are thoroughly agitating it, in the light of the days of the art of Everson?

A. Yes, in that light I am thoroughly agitating it.

You can see by the gray color of the water that the gangue is coming out of the mixture.

Now, I have transferred that to the batea, and I am going to wash it the same way as I washed the other. I would like to show your honor the transposition of the sand and the mineral.

Now, you see the sand remains at the bottom, and the mineral is moved forward by the flow of the water.

Q. 60. Now, what is left in the batea?

A. At this time the sand remains in the batea. Of course there is a little pyrites which has fallen away from the compound of the oil and the mineral.

Q. 61. And in the other operation what was left in the batea?

A. The mineral was left in the batea in the other operation.

Q. 62. And the sand?

A. And the sand was all gone.

This is the overflow or the lighter portion which I show your honor in the big pan, which consists of the mixture of oil and mineral.

MR. SCOTT: Before passing this I would like to call the court's attention to the amount of mineral there in the batea. He said the mineral was washed away, but there is some there.

MR. WILLIAMS: It was not a one hundred per cent operation.

Q. 63. You will supply specimens of this operation for assay?

A. Yes.

Q. 64. Now, this operation that you have just per-

Arthur Howard Higgins.

formed in court, have you performed it many times.

A. Yes, I have.

Q. 65. And have your results been generally successful or not?

A. Well, the results vary somewhat. If you take an oil that has great viscosity you can get an excellent result as far as the recovery goes, but you are liable to include some of the sand with the mineral and so get a low grade of concentrate. If, on the other hand, you take a thinner oil, you get a very high grade concentrate, but some of the mineral drops out of the oil combination, and it stays in the place where it should on the table, and of course that goes in with the sand in that case.

Q. 66. How do the results of this operation that you have just performed compare with the best that you can do in a spitzkasten overflow or upcast such as you have tried before you tried this?

A. I am convinced that this result could be repeated on a large scale and you could get satisfactory treatment by agitating it. On the other hand, if you take a spitzkasten it would be a hopeless affair; one could not possibly obtain any satisfactory results of any kind whatever.

Q. 67. So that this is the only way that you have been able to carry out that second method and obtain fairly good results, is that right?

A. Yes, that is correct.

Q. 68. And what is your opinion as to whether or

Arthur Howard Higgins.

not what you have done is the particular thing that Mrs. Everson discloses in her specifications?

A. I think I have done everything which she discloses, except perhaps I have not taken an ore that did not contain any alumina. This ore does contain some alumina, and for that reason it might be somewhat less satisfactory than what one might obtain with clean white quartz. I would like to point out that the method using the batea in both the vanning operation and the other operation when I was repeating the Everson was the same. There was no difference in any movement, except perhaps that at one time the batea went around a little further than at another time perhaps, but in each case the lighter stuff was washed off by the operation of the batea furthest from the body of the operator and the heavier stuff remained behind in the batea itself.

Q. 69. Now, in the first operation the sand was washed over the edge of the vessel?

A. Over the edge of the batea.

Q. 70. Did it float off?

A. No, not in the true sense of the word. In the metallurgical sense, particularly at that time, the sand was floating off.

Q. 71. But in fact the sand didn't float?

A. No, in fact the sand did not float, it was carried in suspension in the water.

Q. 72. And was it or was it not heavier than the water?

A. Yes, the sand is heavier than the water.

Q. 73. Now, in the Everson second method as car-

Arthur Howard Higgins.

ried out in the batea what was carried over the edge of the vessel?

A. The mixture of oil and mineral.

Q. 74. Was this mixture of oil and mineral heavier than the water or lighter than the water?

A. Heavier than the water.

Q. 75. Did it float?

A. Not in the strict sense of the word, but in the metallurgical sense used at that time, it floated.

Q. 76. And how was it in fact carried over the edge of the vessel?

A. Well, in fact it was carried over in suspension.

Q. 77. When material is carried in suspension by a flow of water, may or may not that material be sinking in the water as it is carried?

A. Yes, that is usually sinking, sometimes very slowly, but it must sink at some rate.

Q. 78. Can you find any references in the literature of the days preceding the Everson patent as to the use of the word "floating?"

A. Yes, I have some references, page 355 of Ure's Dictionary of Arts, Manufactures and Mines, published in 1860, in describing Brunton's machine says: "The heavier particles lodged on the cloth, are caught in the waggon, R. whilst the lighter matter is floated over the roller M."

Q. 79. Now, what was described by the words you have just quoted, "the lighter material is floated over?"

A. That is a description of a separating operation

which is the counterpart of the operation with the batea which I have just shown.

Q. 80. "The lighter material is floated over," is the sand and slime, in suspension in the water?

A. Yes.

Q. 81. Now, can you give me another reference?

A. On page 330, under the heading of "separation"

Q. 82. Read the sentence.

A. The book is describing the principles of a separator. "The prevailing principle is that of directing a pressure of water against the density of the descending material, making the former sufficiently powerful to float off certain minerals with which ore may happen to be associated." That use of the word "mineral" there includes the gangue. It is not used to designate only "metalliferous mineral."

Q. 83. And the use of the words "float off" there describes what?

A. That is exactly the same operation, the removal of the lighter portions of the stuff in suspension in water.

Q. 84. Have you another refernce?

A. 352.

MR. SCOTT: I want to call the court's attention to the fact that even with this mild manipulation, particles are coming to the top, and with a magnifying glass the bubbles can be seen, even under the limited manipulation that was given to it in this experiment.

At the bottom, little bubbles, shining, can be seen,

P. 4479, L. 31, insert "Q. 91. What have you to say as to the significance or"

Arthur Howard Higgins.

and by looking at the thing closer when it is turned a little, every little while one of these will rise up and there is quite a coating of them on top as it is now.

Q. 85. MR. WILLIAMS: In other words, it is a floating froth?

MR. SCOTT: I am calling attention to the fact that even under the restricted agitation which was given to it, the tendency to rise was ~~can~~ not ~~be~~ defeated.

Q. 86. MR. WILLIAMS: You have heard the remarks of counsel, Mr. Higgins?

A. I have.

Q. 87. Will you testify as to what the facts are?

A. The facts are that there is less than one per cent of the material floating. I think I might say with a great deal of truth it is less than one-five-hundredths part of it floating.

Q. 88. And what do you attribute that float to, in the bottle into which the material was dumped?

A. I think at least one-third of that is floating by surface tension. A great deal of the float is due to the buoyancy of the oil, and there are some air bubbles in it.

Q. 89. Is it or is it not a fact that the water that you used, Butte water, is saturated with air?

A. Yes, we used water saturated with air and we put sulphuric acid into it. It is possible there may be a small quantity of calcite in the ore which would generate bubbles of gas.

Q. 90. How was the material put into this bottle?

A. ~~I think it was washe ddown through a funnel.~~

A. I think it was washed down through a funnel.

~~on~~ the metallurgical value of anything that can be said to be a float on that bottle?

A. It is of no significance whatever. It means that you lose a little bit of the stuff. That is all. It is absolutely of no metallurgical value.

Q. 92. Please continue your answer.

A. Under the heading "Percussion Table, or Stossheerd," "The stuff to be washed—" that of course is the ore—"is placed on the chest (a), into which a current of water runs. The ore, floated onwards by water, is carried through a sieve on a small sloping table (x), under which is concealed the higher end of a movable table, (d), (b), (c), (u); and thence falls on this table diffusing itself uniformly over its surface." The illustration here is very much to the point because the description is of a bumping table which Everson evidently intended to use and the same term is used "floating" where it refers to the material carried in suspension over the table. I have another quotation on page 362 under the heading "Slime Pits." "In the several operations of cleansing ores from mud, in grinding, and washing, where a stream of water is used, it is impossible to prevent some of the finely attenuated portions floating in the water from being carried off with it."

Q. 93. Now, as to this last expression, "floating in the water." In the first place, what does that refer to; what sort of an operation?

A. That refers to the washing of ores to get rid of

Arthur Howard Higgins.

the clay or slime material that has been formed during crushing of the ore.

Q. 94. And what is the material which is said to be "floating in the water" in this description?

A. It is referred to, I think, as slime, "some of the finely attenuated portions"—that means some of the stuff that we call slime, the very finely crushed material.

Q. 95. Where slime may be described as floating in water, how would you accurately describe it?

A. As being carried in suspension.

Q. 96. Now, in connection with the Everson specification, Dr. Sadtler discovered a third method of Everson as described in the paragraph on page 3, lines 17-24. What have you to say as to the disclosure of the specification at that point?

A. The method there disclosed is exactly the same as the second method, the only difference being in the kind of oil used. I have tried that proceeding with the smaller quantity of oil which is disclosed in the first example, that is 4.97% of oil. I used cottonseed oil for that experiment, and I found that it was impossible to make the stiff mass which she tells you to produce in line 36, page 2 of the specification. On putting the very dry sort of powder into water and attempting to manipulate it in the manner that she further described in line 53 of the specification, page 2, it was impossible to make the plastic mass which is requisite in carrying out the example. If one takes the quantity of oil that

is described in the use of the second method, that is, 17.1%, then the process works exactly as the process where you use petroleum or a constituent, so that the disclosure is the same as the second method, what we call the second method, the only difference being the matter of the oil.

Q. 97. And what oil did you use?

A. Cottonseed oil in both cases, both these tests that I referred to just now.

Q. 98. Cottonseed oil, is that the oil of the first method?

A. That is the oil that she tells you to use in the first method.

Q. 99. If you were to repeat that operation with cottonseed in the same proportion that the paraffine oil was used, would the operation be just as you have demonstrated in court, or what?

A. The operation would be exactly the same; I don't think anyone could see any difference by observing the operations or any difference in the results.

Q. 100. I don't think you gave the specific gravity or the description of the oil that you used in your second Everson demonstration.

A. The oil that I used was a constituent of petroleum known as engine oil having a specific gravity of .88. There was no particular reason for choosing any particular oil in that case. The quantity of oil which she gives is rather indefinite. She says three fluid grams of a 30° Be. petroleum—which of course is crude oil—

Arthur Howard Higgins.

is sufficient for properly moistening two ounces of heavy ore. She does not tell us what properly moistening means, or what the heavy ore is, but that quantity of oil seems to give the required result. It might be possible that one could get a better result by taking a little more oil.

Q. 101. What percentage of oil did you use?

A. I used 17.1%.

Q. 102. And is that your computation as to the disclosure?

A. That is the computation as to that disclosure I just referred to.

Q. 103. Dr. Sadtler referred to the description on pages 356 and 357 of Ure's Dictionary and the illustration on both pages showing what is entitled a Dolly tub, or packing kieve. Can you give us any information as to the kind of an agitator disclosed in connection with the Dolly tub in that publication?

A. The Dolly tub shown on page 357 is described as a machine Dolly tub. The size is very large. One sees the tub sitting on a railway car. The machine is geared from a water wheel in the ratio of one to one. The water wheel, of course, is a very slowly moving wheel, turned by water, so that the agitator inside the Dolly tub will make about the same number of revolutions as the water wheel does, probably four or five a minute. The hand Dolly tub shown on page 356, Figure 1419, is rotated by a couple of men by hand. Seeing that the load in that agitator practically fills the tub

when the agitator is withdrawn, it is quite certain that such a rotation by a couple of men would be a very slow process. On page previous to this, 355, there is given at the end of the description of Brunton machine, another machine-driven dolly. There is a great deal of detail given with that drawing as to the length of the belts and the rates they go at, so that by making one or two measurements it is possible to find out that that agitator inside the dolly runs from 4½ to 7 revolutions a minute.

Q. 104. Dr. Sadtler called attention to an illustration at page 332 of Ure's Dictionary, Fig. 1379, and Fig. 1380, showing a spitzkasten. Have you anything to add to what you have already said in regard to that spitzkasten?

A. No, there is nothing to add to that. The separator here is not for separating mineral from gangue, but for separating different classes of mineral and gangue.

Q. 105. And particularly what material would overflow from that spitzkasten?

A. Very fine material, consisting of both mineral and gangue, what we call slime.

Q. 106. Then on page 335, Fig. 1385, there is another arrangement which was referred to by Dr. Sadtler. What is the function of that apparatus and for what was it used?

A. That was an apparatus which was designed to separate powdered ore into five different sizes of material, four of them descending through the pipes K, L

Arthur Howard Higgins.

and M and N, and the fifth overflowing at the lip of the spitzkasten. This material, as before, consisted of mixtures of sand and gangue and mineral.

Q. 107. What do you call such an apparatus?

A. A hydraulic classifier.

Q. 108. And what material would overflow from that spitzkasten?

A. The finest material, the actual size of the material overflowing depending on the amount of water you turn into the apparatus at the valve G.

Q. 109. What would you call the material that overflows?

A. Slimes.

Q. 110. And in those days what became of those slimes that overflowed?

A. In those days they were run to waste.

Q. 111. Do you find in the Everson patent, No. 348157, any disclosure of a froth-producing process?

A. No, there is no such disclosure in the specification.

Q. 112. Do you find disclosure in the Everson specifications any procedure whereby a mineral froth is produced?

A. No, I do not.

Q. 113. Now, we will take up the Fryer Hill publication. Have you studied the exhibit known as the Fryer Hill publication which appears in complainant's record in the Hyde suit, pages 738 and 739?

A. Yes, I have.

Arthur Howard Higgins.

Q. 114. Do you find here disclosed the particulars of a process which will enable you to carry it out?

A. No, there are not sufficient details to enable anyone to carry out a repetition of this experiment which is reported.

Q. 115. What are your general conclusions as to the thing that was intended to be described?

A. The description is of some experiment that was made and the results obtained were said to be very satisfactory. In the first instance the operation was carried out on a silver ore that ran over ten ounces of silver. It says that the ore was crushed to enable it to pass through a 40 mesh screen. Of course the operation of crushing in those days, when the slime went to waste, where nobody was able to do anything with it, the operation of crushing was to do it to the end that the minimum amount of slime was produced and that the maximum remained in the coarsest possible degree. There the coarsest possible degree was, of course, 40 mesh. The ore was then mixed with the oil whilst dry and placed into some kind of a tank having a pipe in it, or hollow tube, to which was attached a couple of fans. The action of this tube with two fans at the bottom was described as being "arrastra-like." The arrastra-like fans attached to the bottom of the tube kept the whole mixture in motion. That was exactly the same kind of motion that is referred to in the action of these dollies illustrated in Ure's Dictionary, what we should term now as gentle agitation. Acidulated steam was

Arthur Howard Higgins.

forced from the pipe whilst the ore was kept in motion, and during that time the lighter portions of the mineral-charged oil floated to a point just above the center of the receiver ~~reservoir~~. The article that the reporter is dealing with here is oil containing mineral, and it has to float during the operations to a point just above the center of the receiver. That is another reason why the operation should be carried out in a gentle mode of agitation so that the stuff that does ~~not~~ float is not carried down again violently to the bottom of the tank and thrown in all directions.

Q. 116. What about the metalliferous content of the ore that was treated?

A. Well, the ten ounces of silver might account for the whole of the mineral in that ore, in which case it would be extremely low metal content. And the fact that this oil containing the mineral floated during the operation seems to indicate that there was a very low mineralization of the ore and it was able to carry the whole of the mineral in the same fashion that the Elmore oil carries the mineral in his operation.

Q. 117. That is to say, there was very little mineral to float?

A. In my opinion there was very little mineral to float.

Q. 118. And what, so far as you can gather, were the flotative agents or was the flotative agent employed?

A. Petroleum. That would be crude petroleum. I

don't find any other flotative agent. The steam would collapse in the water. That wouldn't be any flotative agent.

Q. 119. And if the oil was the flotative agent, in what manner would the oil exercise flotative powers; as a result of what?

A. Simply by reason of its buoyancy.

Q. 120. Can you read out of that description any utilization of air bubbles to float the mineral?

A. No. On the contrary air was not introduced by the agitation in this process to any extent, because the description given indicates that the fans attached to the bottom of the tube were rotated very slowly, and in fact they are described as "arrastra-like." They were dragging in the ore which had settled at the bottom of the tank. It is also apparent that it is possible that the oil was being removed at the same time that the agitation was going on, which would be of course impossible if you used the high speed of agitation of the modern art.

Q. 121. Do you find any disclosure there of a rapid, violent agitation, followed by a settling operation giving the material chance to settle?

A. No. On the contrary, I think the indications are the exact reverse of that.

Q. 122. THE COURT: How much oil is mentioned in that publication?

A. There is no quantity of oil given your honor. The ore was crushed and mixed with the oil and it

Arthur Howard Higgins.

does not say what condition the mixture was in after the oil had been added, either.

Q. 123. MR. WILLIAMS: So that you have no proportions there, no direction. No proportions to guide you?

A. No, none at all.

Q. 124. And when you refer to the buoyancy of the oil, what sort of a proposition would it call for?

A. Well, if the mineralization is low, then that amount of oil referred to in the Everson experiment, 17%, that would be ample oil to float the silver by the oil buoyancy method.

Q. 125. Now, a machine has been produced in court and is in evidence as Defendant's exhibit Fryer Hill machine. Have you examined that machine?

A. Yes, I have.

Q. 126. Is that machine described in the Fryer Hill publication?

A. It is not.

Q. 127. Is the operation to which that machine was subjected in the experiments in court described in the Fryer Hill publication?

A. No, the operation is not described. As I already have pointed out, the operation seems to be exactly the reverse.

Q. 128. Now, there was another machine that was offered in evidence known as the Cataract machine; this machine being said to have been made from a drawing and description appearing in a book by Louis

Edgar Andes. Have you had a drawing made contrasting that exhibit, Cataract machine, with the drawing shown in that publication?

A. Yes, I had the machine carefully measured and drawn and the illustrations put side by side so as to visualize the extension of the machine in depth.

Q. 129. Now, the drawing to the right, is that the defendant's cataract machine?

A. That is the defendant's cataract machine.

Q. 130. And the drawing to the left?

A. Is the drawing from the illustration from Andes on the same scale.

Q. 131. What is the significance of that great addition to the height of the machine which has taken place in defendant's reproduction?

A. The significance there is that the increased depth in the machine makes it possible to use a much higher speed of agitation. In the operation of that machine as I saw it here, the liquid was extending for half an inch or three quarters of an inch above the disc.

Q 132. Above the rotating disc as shown in the drawing of defendant's cataract machine?

A. Yes, referred to as "this cover." Now, if that same rotation had taken place in the actual machine made according to the illustration, there would have been a tremendous loss of material; it could not possibly be run at that speed.

Q. 133. It would overflow from the edges would it not?

Arthur Howard Higgins.

A. Yes, it would have come over the top.

MR. WILLIAMS: Drawing produced by the witness offered in evidence and marked defendant's exhibit 254.

Drawing admitted in evidence and marked DEFENDANT'S EXHIBIT 254.

Q. 134. I call your attention to exhibit entitled complainant's exhibit, Criley Everson publication, appearing on page 740 of complainant's record in the Hyde suit, and ask you if you have studied that publication?

A. Yes, I have.

Q. 135. Does it or does it not disclose such particulars as will enable you to carry out the process?

A. In my opinion it does not.

Q. 136. What is the significance of that part of the description which says: "A thick scum of sulphurets rose to the surface and was skimmed off, leaving the hitherto black ore as white as snow—in fact pure silica."

A. That was some floating material which was obtained on the surface of the water, which must have consisted of some part of the ore which is called there sulphurets, being the old word for sulphide, mixed with oil. As to what it was exactly, whether it was an oil layer or not, I cannot tell you, or whether it was a froth.

Q. 137. Is the word scum descriptive or not of the Elmore float?

A. Yes, scum is used for oil floating on water.

Q. 138. Now, we will take up the Kirby patent, No. 809,959. In the first place it has been said that Kirby discloses an operation of agitation and froth separation, and that everything else in the specification is supplemental thereto. What have you to say as to that?

A. That is not so. The process described on page 1 of the specification consists of four steps, but the operation as carried out is very clearly seen in figure 1 of the specification. There the ore and water, with the oil mixed together, in tank "A." There is no provision at all in that tank for taking off anything whatever except through that small pipe which comes out of the right hand bottom corner. You could not possibly take off any floating material at all; it must be the mixture of oil and ore and water which we call the pulp.

Q. 139. In the operation of that tank the material flows out at the bottom?

A. Out at the bottom.

Q. 140. What does the wave like dotted line at the top of the drawing suggest to you?

A. It suggests that the thing is rotated gently?

Q. 141. And when you use the word "gently" just what do you mean?

A. Well, that would be called agitation in the prior art; we should not call that agitation at the present day; we should not call that agitation at the time of Cattermole. The surface of the liquid, if it

Arthur Howard Higgins.

were in violent agitation, would, I think, be drawn quite differently.

Q. 142. Passing from the thing that drawing indicates to the language that Kirby uses in his specifications, how does he describe the agitation that takes place in tank "A" described in the specification as the mixing tank?

A. Well, he calls that "thorough agitation" or "thoroughly agitated."

Q. 143. And does he state the purpose and function of that agitation?

A. Yes; that is to break up the oil into globules. That is to say, in contrast to the Elmore process, where the oil is not broken up; so that all he needed was slight agitation that was a little bit more violent than Elmore.

Q. 144. And having in mind the fact that in claims 1, 2 and 3 of Kirby the words "violently agitated" are used as descriptive of what takes place in the mixing tank "A," and the words "gently agitated" are those used as descriptive of what takes place in the separating tank B—did you have that in mind?

A. Yes, I had that in mind.

Q. 145. And what is its significance to you?

A. That the agitation in tank "A" was considerably more violent than in tank "B." In tank "B" the agitation would be extremely gentle, so as not to break the surface of the pulp.

Q. 146. Now, you have said that in the mixing tank "A" nothing is taken from the surface?

A. No, there is no provision for taking anything from the surface there.

Q. 147. And in a continuous operation, would it or would it not be possible to take anything out, any flow from the surface?

A. It would be impossible.

Q. 148. Now, the separating tank B, what is the function of that tank?

A. That tank is a tank that is specially prepared for separating the layer which comes from the pulp when it gets into this region of lesser agitation. The separating tank has an agitator which carries with it air pipes and oil pipes, which are shown in figures 4 and 5. There in the separating tank you have the pulp coming in through the small pipe just below the surface on the left hand side, with streams of air and oil coming in through the agitator, which have to rise to the surface. That indicates that the agitation must be such that the oil and air is not carried down again into the body of the mixture.

Q. 149. And how about the disturbance of the surface?

A. In such a case there should be no disturbance of the surface, except what must be caused by the bursting of air bubbles in it.

Q. 150. Now, have you had constructed an apparatus in accordance with the Kirby drawings?

A. Yes, I had such an apparatus constructed. It was a matter of great difficulties, such as in getting air pipes through the center rotating tube. No pro-

P. 4494, L. 30, after "great" insert "difficulty because in several places *we* found mechanical"

Arthur Howard Higgins.

vision is made there for the proper junction of these different pipes as they pass through the central tube. It leads one to believe that that is a drawing that has never been reproduced on a large scale, or these defects would have been remedied.

Q. 151. That is to say the drawing indicates that it was not a drawing made from an apparatus?

A. No; the drawings could not possibly have been made from an apparatus, or they would not have left these defects which are somewhat serious and gave us a good deal of trouble in reconstructing the apparatus.

Q. 152. But did you make an apparatus in exact accordance with these drawings?

A. I had one made, yes.

Q. 153. And you have that apparatus in court?

A. Yes, it is here in court.

Q. 154. And will you in that apparatus carry out the Kirby process?

A. Yes.

Q. 155. What ore will you use in carrying out the Kirby process?

A. We shall use some of the ore from the Rossland mine.

Q. 156. Is or is not that the particular ore described in the Kirby specification?

A. That is the particular ore; you will find the reference to it on page 1, line 58, and again on page 2, line 16.

Arthur Howard Higgins.

Q. 157. And in carrying out the Kirby process in the Kirby apparatus with the Kirby ore, what oil will you use?

A. A mixture of 95 per cent of kerosene with 5 per cent of semi-solid residuum of petroleum distillation, which happens in this case to be some Roumanian residuum.

Q. 158. And in what proportion to the ore?

A. I have taken the lower limits, 25 per cent. I will mix that up in the upper tank, tank "A," and then afterwards run the streams of the same oil through the pipes in the separating tank.

Q. 159. And that will be how many pounds of oil to the ton of ore?

A. 25 per cent is 500 pounds.

Q. 160. And when you carry out the Kirby minimum proportion of oil, what do you get?

A. You get a layer of hydro carbon liquid floating on the surface of the separating tank, with the air bubbles passing through it, and at the lower surface of the hydrocarbon, just at the junction of the oil and water, you get a certain amount of mineral floating.

Q. 161. MR. SHERIDAN: Where is the Roumanian residuum from, Mr. Higgins; I was not sure I understood you correctly?

A. It is from Roumania.

Q. 162. MR. WILLIAMS: What do you understand to be the part of the specification which authorizes the use of this Roumanian residuum?

P. 4496, L. 17, after " Kirby " insert " process in the Kirby apparatus with the Kirby ore and the Kirby "

Arthur Howard Higgins.

A. On line 23, on the second page it says, "Trinidad Asphalt." I cannot get any of that; most of that stuff seems to be shipped to South America; so I got some of the "semi-solid residuum of petroleum distillation," which is about the same. The reason why I took the Roumanian stuff was because if there was any chance of getting any kind of a froth, that Roumanian stuff is much more likely to give it than the Pennsylvania residues.

Q. 163. Now, I read from the specification, page 3, line 55, "The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer where it is in contact with the water." Please state whether or not that language describes the kind of float that you get in this experiment?

A. Yes, that describes the float exactly. The hydrocarbon contact with the water should not be expected to be absolutely flat; that gets crumpled up more or less, and gives it an irregular shape.

Q. 164. So that down in the interface or just above the interface you find most of the metal, is that right?

A. Yes, in the upper surface of that layer of hydrocarbon I don't think you find any metal at all.

Q. 165. Now, I again read from the specification, page 3, line 37. "The rotating movement of which leads the floating scum of hydrocarbon liquid, air bubbles and concentrates," etc., does that describe the float that you get?

A. Yes, it does. The scum, there, of course, refers

to all three, liquid, bubbles and concentrate, the liquid being the chief constituent.

Q. 166. And when you say hydrocarbon liquid, you mean what?

A. The mixture of kerosene and residuum.

Q. 167. In other words oil?

A. That is what Kirby constantly refers to as solution.

Q. 168. Do you find air bubbles in that float?

A. Oh, yes, air bubbles are there, chiefly at the upper surface of the oil, and quite free from any mineral.

Q. 169. And what happens to those air bubbles as a general rule when they get up there?

A. Well, they generally burst before they get out of the tank.

Q. 170. I read again from the specification, page 2, line 53: "Some of the hydrocarbon coated particles will float to the surface without assistance; but a considerable quantity of such particles will not be sufficiently buoyant." What do you understand to be the significance of that part of the specification?

A. The hydrocarbon coated particles that float without assistance are undoubtedly floated by the buoyancy of the oil. The others that requre assistance, his object is to attach air to them or oil from his oil streams or air streams, and so raise them to the surface.

Q. 171. That is to say, they will not be sufficiently buoyant until they receive that assistance?

A. Yes, that is what he means.

Arthur Howard Higgins.

Q. 172. And when those particles are thus raised to the surface, what happens to them?

A. Well, they settle down in the oil-water interface, and if they do not happen to fall out of that, they eventually find their way out of the tank through the opening, which is much better shown in another specification where he gives the details of the construction of the tank.

Q. 173. Do you mean figures 2 and 3, sheet 2?

A. No, in the apparatus patent. He gives here the detail drawing of the discharge, which you can see very much better. It is much the same in figure 3.

WHEREUPON an adjournment was taken until 2:00 P. M., May 11, 1917.

2 o'clock p. m. Friday, May 11, 1917.

Q. 174. You may refer to the second Kirby patent, No. 838,626, and the drawing thereof which appears at page 758 of the record in the Hyde suit. You might briefly describe what is shown in that drawing, to which you particularly referred.

A. That drawing shows the tank partly broken away so that the discharge opening "a3" is clearly observed. Two dotted lines immediately inside from there, one of which represents the upper edge of the spitzkasten R, and the lower one a portion of that upper edge cut away so that the floating layer of liquid can pass over the lower portion and be retained by the upper portion. That layer that flows on through the opening a3 and is discharged into the centrifugal machine.

Q. 175. And what is the function of the pipe marked s^1?

A. That brings down wash water, clean water, to wash away the slime which is carried by some of the water which escapes over the edge marked r^1.

Q. 176. Is there a bottom outlet for that little spitzkasten R?

A. Yes, the spitzkasten R is shown in the plan to be divided up into five compartments and there are holes at the bottom of the compartments to discharge the gangue back again into the separating tank.

Q. 177. So that that is a species of washing of the float?

A. Yes.

Q. 178. And the upstanding part marked "r^2" is the part which you say extends upward above the liquid?

A. Yes, that extends upward above the top of the floating layer of hydro-carbon liquid.

Q. 179. Now, turning back to page 740, the drawing, sheet 2 of the process patent, No. 809959 and looking at the Figure 3, do we see there a section of the spitzkasten and the overflow or outlet?

A. Yes, the section there is very much the same.

Q. 180. What is the outlet marked?

A. 32.

Q. 181. And the wash water part, what is that marked?

A. Wash water part is marked 35.

Arthur Howard Higgins.

Q. 182. And the opening at the bottom of the spitzkasten for the slimes to drop through?

A. That is marked 33. The drawing does not show quite so well the difference in the level between the two parts of the spitzkasten, that is the part between 29 and 30, and the part between 29 and the other side of the tank, you might say, 32.

Q. 183. Now, refer to the specifications for a description of the details of this construction.

A. That is given on page 3.

Q. 184. Page 735 of the record?

A. Line 23. "The edge of this box outside of the skimming bar"—That "outside" there refers to the part between 29 and 30—"is submerged sufficiently to allow the floating material to pass over it, while the remaining parts of said edge is raised above the liquid so as to detain everything passing into it," that is the reason. The part 29 in the direction of the discharge opening 32 is raised so high that it retains the layer, what we call the floating scum, and is here defined as being the liquid.

Q. 185. And when he says, in his specification, "above the liquid" what surface does he mean that it extends above?

A. That is extends above the upper surface of the floating layer of hydro-carbon liquid.

Q. 186. And you might read the following part of the specification.

A. "Owing to the agitation within the tank caused

Arthur Howard Higgins.

by the movement of the arms 23, and the rising air bubbles, the water, even near the top, is not clear, but turbid or muddy with slimes or particles of the non-coated minerals which do not settle rapidly enough to get out of the way."

Q. 187. What does he mean by the "non-coated minerals" there?

A. He is referring there to the gangue.

Q. 188. In ~~these~~ this specification~~s~~ is the term "mineral" applied both to the metallic mineral and the gangue?

A. Yes.

Q. 189. And then the next statement of the specification I have heretofore read: "The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer, where it is in contact with the water." Then, following that, "The discharge gate, 32, in order to permit these floating particles to pass by must be set low enough to clear them and must therefore allow a portion of the water to pass out with the skimmings, and this muddy water would therefore carry some suspended particles of worthless minerals, which would make the concentrate impure. The settling or concentrating box is designed to prevent or lessen this evil." That refers to the function of the settling box, and the object of it?

A. Yes, including the wash water which comes down through the pipe marked 35.

Q. 190. Now, have all these details been repro-

Arthur Howard Higgins.

duced in the Kirby machine that you are about to use?

A. There is a slight difference in the suspension of the skimming bar as compared with this drawing in figure 2.

Q. 191. And what is that difference?

A. We have that fastened on to the little spitzkasten.

Q. 192. How is it as to position?

A. I think the position is about the same.

Q. 193. That is to say instead of fastening it on to bars extending across the top of the machine, you have fastened it directly to the spitzkasten?

A. Yes.

Q. 194. Does it function the same?

A. Oh, yes, quite.

Q. 195. Now, in this operation in the Kirby machine with the Kirby ore, what are you going to do?

A. I am going to take some of the Rossland ore which has been crushed to 80 mesh.

Q. 196. In crushing it to 80 mesh have you followed the directions that you would take from the patent as of Kirby's day, the day of filing of Kirby's application?

A. I think perhaps I have erred slightly in that; I might have taken 40 mesh or 60 mesh. It is an error in the right direction.

Q. 197. Proceed.

A. That amount of ore, 4000 gms., will be mixed with water, with 1~~5~~4 litres of water.

Arthur Howard Higgins.

Q. 198. That is how many gms. or c.c.?

A. 14,000 c.c.

Q. 199. And that is what relation of ore to water, what proportion?

A. Three and a half of water to one of ore.

Q. 200. What are the directions stated in the specifications of Kirby?

A. The specification gives three or five times the amount of water to ore, so that that proportion is within the disclosure of the patent.

Q. 201. What will you add to the ore and water?

A. To that we shall add 60 gms. of sulphuric acid, which is at the proportion of 30 pounds to the ton of ore.

Q. 202. Do you find your authority for that in the Kirby patent?

A. Yes, he says: "The preference of the water for other mineral particles may be regulated by adding some acid or other chemical."

Q. 203. Have you tried it without acid?

A. Yes, I think I have.

Q. 204. And which has given you the best results?

A. The presence of the acid improves the result.

Q. 205. What else will you do?

A. To that mixture we shall add a thousand gms. of kerosene and Roumanian residuum, 95 per cent kerosene, and 5 per cent of residuum. The amount of the oil added will be 25 per cent to the ore.

Q. 206. How will you proceed?

A. After agitating those together in A tank for

Arthur Howard Higgins.

ten minutes, they will be discharged into "B" tank, which is the separating tank, and there they will be treated to streams of oil and air as described by Kirby in his specification.

Q. 207. Those streams of oil and air will flow from whence?

A. They will flow from head tanks through the agitator into small pipes at the bottom of the agitator, which distribute the oil and air.

Q. 208. So that the agitation, as it slowly rotates, will distribute streams of oil and streams of air?

A. Yes, with the object of assisting the concentration of the ore, of the oil coated minerals which have not floated to the surface with their own buoyancy.

Q. 209. Now, will you start the operation? At what speed will you rotate the agitator in the mixing tank?

A. At 192 r.p.m., but this will be reduced to 188 with the load of ore.

Q. 210. And the lower or second vessel, what speed of rotation will you have?

A. 30 r. p. m.

Q. 211. Are you going to use baffles in the mixing vessel?

A. Yes. Without the baffles the oil is not satisfactorily broken into the small bubbles that Kirby directs you to obtain.

Q. 212. What would happen if you have the liquid in the vessel and rotate it as fast as you do without baffles?

A. You would get a beautiful shower of water over the edges.

Q. 213. It would overflow from the vessel?

A. Yes.

MR. GARRISON: If your honor pleases, each side is, by mutual consent having the record and transcript of the trial printed jointly just as it is transcribed by the stenographers, and we desire to have your honor's permission to have this constitute the record and transcript on appeal.

MR. SHERIDAN: That is satisfactory.

MR. GARRISON: Now, if your honor pleases, we have taken up between ourselves the question of the oral argument, and of the brief thereafter, and we desire to submit to you what will be agreeable to counsel, if it meets your wish.

Our agreement is as follows: As to the oral argument, the plaintiff to open and reply, each side to have seven and one-half hours. Each side to divide its own time as it sees fit among as many counsel as it pleases.

As to the brief, each side to file a main brief on or before the first day of July, 1917, and to have three days extra for the service thereof upon the other side.

Each side to have twenty days for filing a reply brief, the twenty days to run from the time of receipt of service of the main brief; and to have three extra days for the service of such reply brief on the other side.

Arthur Howard Higgins.

May I inquire if that is satisfactory to your honor?

THE COURT: It may be entered in accordance with the court's order and approval.

Q. 214. MR. WILLIAMS: Now, will you add anything that is necessary to complete the description of the operation as you carried it on?

A. The mixture was agitated in the tank A for ten minutes and then discharged to the tank B. The tank A was practically completely discharged in 11 minutes. The operation was then stopped. What was left in tank B should be considered to be only partially treated material and left out of the consideration as far as the results go. The results should be taken as comparing the separated concentrates with the separated tailings, with reference to the oil that was fed into the tank.

Q. 215. What sort of a float did you obtain in the separating vessel or separating tank?

A. In the separating tank there is a thin layer of hydro-carbon with mineral carried chiefly at the oil-water interface. The layer of course was not flat, because of the disturbance caused by the rotation of the agitator and also the passage of the air through the pulp. The stream of the float which came through the pipe into the receptacle separated very clearly into two layers, one of the oil and the other the interface which carries the mineral. In that receptacle of course the interface is a good deal cramped and it rolls itself up into all kinds of funny shapes.

Q. 216. And the concentrate that you have obtained, is that in this vessel?

A. Yes, it is.

Q. 217. And how would you describe that concentrate?

A. The concentrate is separated into two parts, one of which appears to be clean oil at the top with a very few bubbles in it, the under layer being largely water, oil and concentrate.

Q. 218. How many bubbles did you count there, estimating them?

A. I should say there was about twenty small bubbles.

MR. SCOTT: Do you mind if I ask Mr. Higgins where the water is, and where he sees the two layers so plainly?

Q. 219. MR. WILLIAMS: May I ask where the water is, and where you see the two layers so plainly?

A. On top there you see the water,—

Q. 220. MR. SCOTT: On the top the water?

A. On the top the oil. Now as you move it from side to side you can catch a glimpse of that layer underneath.

Q. 221. Of what?

A. That is the water layer, and between the two you get the mineral.

Q. 222. MR. SCOTT: What is on the bottom of the pan?'

A. That is a part of the water layer which is sticking to the pan. There is some gangue in that, and

Arthur Howard Higgins.

there seems to be some mineral also. If we had this put into a bottle it would become perfectly clear that there are two layers in it.

Q. 223: MR. SCOTT: How much oil was there in there, would you estimate, or is there any way of telling?

A. If you would pour this into a large bottle, I think we should be able to see the layers very much better.

Q. 224. Describe it to the court.

A. Having put the concentrate, into a bottle, the two layers are very clearly discernable. The crumpling here is due to the compression of the interface of the oil and water. The upper part of the oil layer appears to carry no mineral at all, and underneath that is the water and between the two the mineral.

Q. 225. MR. SCOTT: Point out the mineral.

A. The mineral is seen here in this space.

Q. 226. About an inch deep?

A. Not quite.

Q. 227. Three quarters?

A. Say there is three quarters of an inch there.

Q. 228. You don't mean to say that that three-quarters of an inch is the interface?

A. That is what it is exactly.

Q. 229. The interface is three quarters of an inch thick?

A. The interface has been crumbled up just as I say in that bottle.

Q. 230. There seems to be a division of the oil and mineral and the water below the mineral?

A. The interface of oil and water is crumpled up and the oil is above. The bottle does not give it a chance to spread out. If we had it in a larger vessel it would spread out into a horizontal surface, and still carry the mineral.

Q. 231. Why isn't it crumpled and irregular on this edge if there is such a crumpling; it is a perfectly plane surface, it looks to me, between the oil and the water. I want you to explain how this crumpling and intermingling is, and where it is?

A. There, see; that moves the interface over there and you get a cleaner surface there; there it is quite sharply defined, the demarcation between the two; so that if you put this into a large area, you give that interface a chance to spread out in its normal position.

Q. 232. What holds up the mineral shown here below the oil; isn't this mineral, this dark layer?

A. Yes, but the oil goes down through into that just as much as the water does; exactly as it does in that case where you have got that gold paint or bronze powder suspended in that interface; there you see the interface is crumpled up.

Q. 233. There are films which drop off there, but we have no body of mineral here. You have a body constituting a stratum, and according to you it is all interface. In this specimen of ours there is just an interface with shreds hanging from it, isn't that so, with this bronze stuff.

A. Exactly; but there you have only about enough

Arthur Howard Higgins.

bronze in it to put on the head of a pin, while here we have got a considerable quantity.

Q. 234. This assumes a sharp line between the two, doesn't it?

A. So does this.

Q. 235. MR. WILLIAMS: Now, Mr. Higgins, in this material as you have put it in the bottle, there is on top a deep black layer; what is that deep black layer?

A. That is the oil.

Q. 236. And does that or does it not contain mineral?

A. There are a few bubbles carrying mineral in the oil.

Q. 237. And the lower line of that black oil also appears to be quite well marked, does it not?

A. It does.

Q. 238. Is that the lower line of the oil?

A. That is the lower line of the free oil, and underneath there is the crumpled up interface. That interface of course settles as nearly as it possibly can to a horizontal plane?

Q. 239. And above that crumpled up interface is what?

A. The clear oil. The interface itself carries the mineral, and below the interface, which is very badly crumpled up, some places extending down three quarters of an inch and other places less—below that you have the water which carries a little of the slime gangue.

Arthur Howard Higgins.

Q. 240. The greater part of the mineral is carried between the water and the oil, is that right?

A. Yes, practically the whole of it.

Q. 241. MR. SCOTT: Now, isn't it a fact that you have a dark colored stratum which we might call black, and that is the oil?

A. Yes.

Q. 242. And below that you have a lighter colored body, and the two are separated by a sharp line?

A. Yes.

Q. 243. As viewed from the outside of the bottle, the only place we can see it from?

A. That is so.

Q. 244. Will you point out to me what you mean by a crumpled interface; tell me where I can see it; I cannot see it myself.

A. When the interface is loaded that way with mineral it does not flow so readily, you know; it becomes very much more viscous, and it can be bent and squeezed up and turned over as you see in the bottle with the gold paint, and I think I can show you that very clearly if I take a little of this crumpled up interface out of the separating machine and put a little of it in water and let it spread out.

Q. 245. What is in the bowl?

A. Plain water. I have taken some of that mass out of the separating tank and if we put that in the water, I think I can show you that it will expand and give you a thing which you will recognize more or less as an interface.

Arthur Howard Higgins.

Q. 246. Now, what happens?

A. The oil spreads out. You see that the dark color of the mineral and the interface spread out and here is the oil and there the water.

Q. 247. But you have a mere film of infinitesmal thickness here, haven't you?

A. You see by moving that film you can open the crumpling in that interface. You see where that moved out and spread into a flat surface, which is just what one expects of course.

Q. 248. What moves?

A. Why, you see, I am coaxing it so as to move it out; by coaxing it you can spread it into a plane. You see how it spreads into a plane and crumples.

Q. 249. Is not the crumpling merely the configuration of the floating particles that are floating on the surface there?

A. The floating particles show you the configuration of the crumpling. It is not the floating particles themselves. The floating particles cause the crumpling, but it is not entirely due to that; it is due to the loading of the interface.

Q. 250. Where there are no particles you have just a flat surface of oil?

A. No, you have particles there.

Q. 251. It is not crumpled where the particles are not found?

A. No; those—that is right. I have uncrumpled it by coaxing it out.

Q. 252. MR. WILLIAMS: Can you express that

Arthur Howard Higgins.

crumpling up of the interface in a little different language; is there something hanging down?

A. Yes, it hangs down.

Q. 253. What hangs down?

A. The interface.

Q. 254. And what else, if there is anything else?

A. Well, there is some oil there and some mineral and probably some water all mixed up together.

Q. 255. And what you did in this flat vessel was to give the material a full opportunity to spread, you said?

A. Yes

Q. 256. What has resulted from that?

A. The interface I have uncrumpled in a good many places, and then it spreads out into what one usually expects to see in an interface, a horizontal plane.

Q. 257. That now which you see in looking down at the top of this vessel in which you have spread out the material by uncrumpling the interface, what are the black particles?

A. There are a good many black particles here where it is still crumpled up, and there is the loaded interface with some free oil and some free water, containing the mineral. But the gray color there where it is spread out which we see show that it carries mineral; in fact you can see the sparkle of the mineral.

Q. 258. MR. SCOTT: If I should stick a match in there, would you say that the match was crumpled up?

A. No; I was speaking of an oil-water interface.

Arthur Howard Higgins.

Q. 259. Well, it is an air-water face if I put a match in.

A. Well, yes, it is bent to that extent; of course the interface is crumpled up to that extent.

Q. 260. MR. WILLIAMS: What crumples it?

A. The presence of the match.

Q. 261. In this instance in the stuff you recovered from Kirby, what crumples the interface?

A. The weight of the mineral.

Q. 262. Now, in operating the Kirby apparatus as you have it, did you get the results which Kirby described?

A. Yes, I got the results which Kirby described, that is the floating layer which contained the mineral, chiefly at the junction of the oil and water, with some air bubbles and a few water bubbles.

Q. 263. And how does that float that you obtained compare with the Elmore oil buoyancy float?

A. The greatest difference is in the position of the mineral. In the Elmore buoyancy float the mineral is spread through the oil by reason of the viscosity; in the Kirby result the oil is so thin that it is not able to retain the mineral in its body. The mineral falls down into the junction of the oil and the water.

Q. 264. And, as I understand you, some of it hangs there?

A. Yes, it hangs there.

Q. 265. Now, in the Kirby specification is the mixing ~~table~~ tank ever used for any other purpose than mixing?

A. No.

Arthur Howard Higgins.

Q. 266. In the disclosure of the specification is there any suggestion that the separating tank B is used for any other purpose than separating?

A. Yes, there is. On page 3, line 118, he says the separating tank may be used as a mixing tank.

Q. 267. And how does he describe the operation as being performed, commencing line 121?

A. Why, when it is used as a mixing tank the agitator is agitated rapidly and when it is used as a separating tank the agitat~~ion~~or is revolved slowly. That operation is very unsatisfactory because the small pipes that run down carrying the oil and the ore are very likely to get choked up with some of the sand during the mixing operation.

Q. 268. Have you tried it under such conditions with the oil in the separating tank and getting the oil pipes choked up?

A. Yes. I agitated on one occasion with the charge in the separating tank and got the pipes badly choked up. Of course the air and oil ~~in~~ there wasn't going through then.

Q. 269. Now, in changing from a condition of rotating the agitating mechanism rapidly to rotating it slowly, did you find any suggestion in these specifications that the apparatus is to be stopped and then started again?

A. No, there is no such suggestion; there are mechanisms known to the art in which we could alter the rotation of the parts of the apparatus without actually stopping it, and such things are commonly used.

Arthur Howard Higgins.

Q. 270. Now, then, if you were to carry out that description what would you do?

A. One would have an arrangement of pulleys or a cone pulley for that matter, which would enable one to go directly from one speed to another speed without making a change in the operation, without stopping the agitator. That would not be necessary, and in large scale operations it would be a baneful thing to do. To start the apparatus again, you probably would have to get a gang of men into the tank to dig it out.

Q. 271. Relative to the Froment patent, Italian and British, were you present when Dr. Sadtler performed an operation said to be a carrying out of the disclosure of the Froment specification?

A. Yes, I was.

Q. 272. What have you to say as to the operation that he carried out, as to whether or not it was what was disclosed?

A. In the first place Dr. Sadtler took an ore for this experiment which was not a sulphuretted copper ore, but the Butte & Superior ore, which contains zinc. The directions of the patent are to take a "sulphuretted copper ore with its gangue and a gram of limestone, the whole reduced to a powder". I interpret that as meaning that the limestone and the ore should be equally pulverized. In the experiments that Dr. Sadtler had made the limestone was very sharp and it appeared to have been sifted and the whole of the fine powder removed. It had the appearance of rather fine-

ly granulated sugar. I do not think that was the intention of the invention.

Q. 273. How about the ore that was used?

A. I have already said that he took zinc ore instead of copper ore.

Q. 274. But what was its conditions as to grinding?

A. The zinc ore was very finely ground. Dr. Sadtler then ~~had then~~ added oil as far as I remember— No, two drops of sulphuric acid. Two drops of sulphuric acid were next added. The specification says "a few drops." In my opinion two is hardly a correct interpretation of the word "few". I think it wants more than two. I found that seven were satisfactory for the purpose. That was followed by one cubic centimeter of olive oil. It wasn't possible to see the exact thickness of the layer in that case because the slime from the ore obscured the edge of the surface of the water and the oil.

Q. 275. And having in mind that the evidence in the Hyde case was to the effect that the Froment process was used at the Travesella mines in Italy, where Froment was the engineer, and having in mind also the specifications of the British patent, what have you to say as to Dr. Sadtler's belief that olive oil was the oil which Froment may have referred to?

A. I think that the oil referred to in the Froment patent was the oil that was used by Elmore. That was the oil used in the art at that time. And he refers to this, he says, "This invention is a modification

Arthur Howard Higgins.

of the oil process of ore concentration." At that time there was no other process in use except Elmore, so that his oil was probably the same. At any rate, it embraced the same oil; and his thin layer is in contradistinction to Elmore's thick layer.

Q. 276. And how about the use of heat?

A. The use of heat would be fatal.

Q. 277. In the operation that Dr. Sadtler carried on, is that or is that not in accordance with the Froment specification?

A. No, there is no disclosure on the use of heat in the Froment specification.

Q. 278. In the operation that Dr. Sadtler carried on what sort of concentration of ores was obtained?

A. There was no useful result in the operation. The float at the surface of the water may have carried a little more zinc than the bulk of the material—that is as far as the grade goes. The recovery was very low, I should say certainly less than one-third of the material in the float, and then it was floated in a perfectly useless fashion.

Q. 279. And what have you to say as to the test tube disclosure as a metallurgical operation?

A. A test tube disclosure is not even a laboratory operation of carrying out a metallurgical process, much less a commercial method, so that the specification in my mind discloses nothing of a metallurgical value.

Q. 280. Do you form your judgment on the amount of material recovered in a float, by inspection?

A. Yes, that is the first judgment one makes of it.

Arthur Howard Higgins.

Q. 281. And, are you or are you not accustomed to doing that in your experiments, some 20,000 or more in number?

A. Yes, I am accustomed to doing that.

Q. 282. Now, turning to the Froment description. What in this do you find, in the Froment description, as to the preparation of the ore? You may summarize that rather than read ~~them~~.

A. The ore is first crushed and then the slime material is washed away in a spitzkasten. Apparently that slime is rejected and discharged to dumps of some kind.

Q. 283. And then the ore that is used is in what condition?

A. The ore that he uses for his process is deslimed ore.

Q. 284. Dr. Sadtler has referred to some experiments made in behalf of the defendant at the Miami trial which he said represented the Froment description. Were you present when those experiments were made?

A. Yes, I was.

Q. 285. And was the ore deslimed or was it not deslimed?

A. In two cases I am perfectly sure it was not deslimed, and to the best of my belief it was not in the third case. The two cases were repetitions of one experiment.

Q. 286. Have you carried out the disclosure of the Froment process, in the Froment apparatus which is

Arthur Howard Higgins.

in evidence in this case, since it was in the Hyde case?

A. Yes, I have tried that many times and as to the results, there is sometimes a little floating material comes up to the surface of the vessel which he calls "the vat with coil". The bubbles bringing up this material usually burst there and leave a thin film which we call skin flotation. Of course with this skin there is a little oil intermingled. The metallurgical result of the process is absolutely worthless.

Q. 287. And in carrying out the description as to the first vessel, the centrifugal mixing vessel, have you ever in any experiment obtained any flotation froth in that first vessel?

A. No, I have not.

Q. 288. And you have repeated the experiment have you, several times?

A. Oh, yes, I have done it a great many times.

Q. 289. When the Froment description was received in the Minerals Separation laboratory what was the condition of the operations there as to the wasting or utilization of slime?

A. Well, the first time I saw that description was some time in 1912. As far as I am aware it had been received by the company some time previous to that.

Q. 290. I am talking now of the evidence in the case which shows that it was received at about 1903.

A. At that time we were using the Cattermole process which was really the first process to successfully concentrate slime material.

Q. 291. Returning to the California Journal of

Technology, have you studied that article in evidence entitled "Experiments on the Elmore Process of Oil Concentration"?

A. Yes, I have.

Q. 292. What general remarks have you to make as to the particular experiments 4, 5, and 6, under the heading of "Tests, Molybdenite Ore", these being the experiments with 2.1% of oil, 5.3% of oil and 8.9% of oil?

A. These experiments show in the first place such low extraction and such low values in concentrates that they are utterly worthless as metallurgical operations. The first experiment was made with 2.1% of oil and the calculation of the results is that they obtained 3 grams of concentrate, that is about 75% of oil to the concentrate. The next experiment they had twice as much oil there, and refer to the same amount of concentrate.

Q. 293. That is, the proportion of oil to the concentrate was about what?

A. In experiment 4 it was 2 grams to 3 grams; in No. 5 experiment it was 5 grams to 3 grams.

Q. 294. Five grams of what?

A. Oil.

Q. 295. To three grams of concentrate?

A. Yes, three grams of concentrate. That would give a concentrate that would yield a great deal of its oil in centrifugal separation, which could be used over again, and I believe that was the method that they adopted. Of course in the third case, that is experi-

P. 4523, L. 30, after " treatments " insert " they have less oil, and when they have one treatment "

Arthur Howard Higgins.

ment No. 6, they increased the oil to 8.9 and they were able to treat that three times.

Q. 296. And what would be a description of these three operations, as you understand them?

A. You mean the three operations in the one experiment, or the third experiment?

Q. 297. No, I am talking about the three operations of experiment No. 6 in the percolating tubes as described at the beginning of the article. Now, how would they proceed in carrying out this third treatment described under experiment 6?

A. In the first place they would make a primary treatment by putting in 8.9 grams of oil, shaking it up violently and separating—I consider that they would separate that concentrate in the centrifugal machine, getting the oil away and using that over again, and make a re-treatment of the tailing.

Q. 298. And those tailings would be the tailings that had been originally treated with the 8.9 per cent of oil?

A. Yes.

Q. 299. And after they got that concentrate, what would they do, take it off?

A. Take it off and separate it again.

Q. 300. And get some more oil out of it?

A. I think they got some more oil out of it, because the significance is that where there were three treatments, when they have the most oil, and when there are two treatments, there does not seem to be enough oil to return to the percolating tube.

Arthur Howard Higgins.

Q. 301. What is your understanding of what happens in these operations, experiments 4, 5 and 6?

A. Well, with that quantity of oil to that quantity of concentrate there was a minimum of 75 per cent of oil. That would make quite a nice thin paste, which ~~he~~ has been described as magma, and that magma would become distended with air bubbles introduced during agitation, and what we would have in the percolati~~on~~ng tube would be the flotation of a magma distended with air bubbles.

Q. 302. How about the salt solution? Is salt a frothing agent, a mineral frothing agent?

A. Salt is not a mineral frothing agent.

Q. 303. Although does it produce a froth?

A. It produces foam in water; I don't know whether that is due to the salt itself or to some impurity in the salt, but one gets it with common salt.

Q. 304. How about the oil, what kind of oil did they use according to the description?

A. The oil they used was a viscous petroleum, a heavy residuum of the consistency of the ordinary cylinder oil, with a specific gravity of about .9.

Q. 305. What kind of oil is that; what is its source and origin?

A. It is one of the constituents of petroleum.

Q. 306. Is petroleum a mineral frothing oil?

A. Usually, no.

Q. 307. When used alone?

A. When used alone. I have found one or two exceptions to that general rule.

Arthur Howard Higgins.

Q. 308. What was the character of the molybdenite ore as far as you gathered from the description and your knowledge?

A. The analysis of the figures showed that the ore contained about 2.3 per cent of molybdenum sulphide or molybdenite. It was crushed to 30 mesh and the gangue minerals were orthoclase and quartz.

Q. 309. What was the character of the mineral?

A. The mineral has a specific gravity of about four and a half, a very brilliant metallic luster and breaks during crushing into thin flakes, which are easily taken up by the oil; much like graphite.

Q. 310. And then this concluding sentence of the conclusion as to the foam effect: "The foam effect is best adapted to light flaky minerals, such as molybdenite." What does that suggest as to the possible usefulness of this foam effect?

A. It suggests that it might be used for the treatment of molybdenite or graphite, but the results that have been obtained are not such as to encourage anybody to proceed in that direction, the results being, as I have already said, metallurgically worthless.

Q 311-A. Is blende a light flaky material?

A. No blende is not.

Q. 311. Is copper sulphide?

A. No.

Q. 312. Or lead sulphide?

A. No, they are not. That sentence could be taken as a warning not to attempt to use those minerals with that foam effect.

Q. 313. How about the sulphides of gold and silver or the native gold and silver; are they light flakey minerals?

A. No; on the contrary gold is a heavy flakey mineral, and sometimes occurs in nuggets, and the other minerals you mention are not flakey. They do not break into flakes during the crushing operation.

Q. 314. Now, are you prepared to carry out the Cattermole process?

A. Yes, sir.

(RECESS).

Q. 315. Now, Mr. Higgins, will you describe the operation which you are about to perform?

A. Three hundred grams of Butte & Superior ore, received by us in 1913, and crushed to 100 mesh, will be agitated in 1500 c.c. of water at 30° .C., containing 1.4 c.c. of sulphuric acid and 16.6 c.c. of oleic acid; that is five per cent of oil on the ore. The agitation will be at about 850 r. p. m., and I shall keep up the agitation about nine minutes. After that the granules will be separated in an upcast.

Q. 316. What will be the proportion of oil on metalliferous mineral in the ore?

A. About 15 per cent.

Q. 317. You say that this ore that you are using was received in 1913? From whom was it received?

A. I think we got it from the Butte & Superior Copper Company on application during the Hyde case.

Arthur Howard Higgins.

Q. 318. It was supplied for the purpose of investigation during the Hyde case?

A. Yes.

Q. 319. And was obtained from the defendant in the present case?

A. Yes. It might have been 1912 when we got it: I am not absolutely certain of the date.

Q. 320. And is the ore—has any change taken place in the ore in that period?

A. Not that I am aware of.

Q. 321. Has it been carefully kept?

A. It has been carefully preserved, yes. The water which I shall use to make the separation—that, is, the water running through the circuit will contain .25 per cent of sulphuric acid.

Q. 322. And when you make the separation in the upcast, how about the water that flows through the upcast?

A. I just said that is acidified with .25 per cent of sulphuric acid.

(The witness performs the experiment with the Cattermole machine).

Q. 323. THE COURT: Now, what was that for?

A. This is to make the granules, Cattermole granules. We stop it there to show there was no froth of any kind.

Q. 324: MR. WILLIAMS: What was the condition, now, of this vessel when it was stopped, what was the condition; what was the material?

A. The granules and the coarse sand had sunk

down to the bottom of the vessel, leaving the slimes in suspension. These are the granules.

MR. WILLIAMS: I ask your honor to observe these granules.

Q. 325. THE COURT: What do you suppose was the recovery on that?

A. I think it was a very good recovery. Yes, I think that is a very good recovery. Of course there is some left in the mixer. We haven't cleaned out the whole of the stuff that we fed in. Of course this is only the coarse sand. The fine sand is still in suspension, or floating, as Everson says.

MR. WILLIAMS: The fine sand—is it slime?

A. Slime, yes.

Q. 326. Now, in this operation that you have just conducted, have you anything to add to your description? In the first place, what did you obtain?

A. I obtained some very well defined granules, I suppose about a millimeter, and perhaps a little larger than that, having the appearance almost of caviare, except it is not quite so black. The sands were extremely white in the slimy portion and contained only a very few specks of dark-colored material in the coarser portion.

Q. 327. And was the recovery a good recovery?

A. Yes, the recovery appeared to be very good. And the grade of concentrate also should be high.

Q. 328. Now, why did you use 5% on the ore and about 15% on the metalliferous mineral in carrying out this operation?

Arthur Howard Higgins.

A. In the first place the ore was crushed very much finer than what Cattermole would have to deal with in his time, and he says that the amount of oil you add, depends, among other things, on the fineness of the ore. In the second place, the gangue has a slight tendency to absorb some oil. which is another factor to be taken into consideration, and in the third place I wanted to get nice large granules that everyone could see without doubt were actual granules, so as to make a fine specimen.

Q. 329. Now, there was an experiment on behalf of the defendant in which the oil was in the proportion of 1½% of the ore; did you see that experiment carried on?

A. Yes, I did.

Q. 330. Did that experiment produce granules?

A. No, those were not granules at all; there was possibly some attachment between the coarse mineral and the fine mineral, one might call that an agglomeration, but they were in no sense granules.

Q. 331. And why did the metalliferous mineral sink in the up-cast?

A. The mineral was—the mineral was subjected to centrifugal action in the low speed of the agitator. That is, when they were running it at 300 revolutions per minute, that is, subjected to the centrifugal separation. The tendency there would be to throw the minerals outside of the agitator and draw the air in at the center of the vortex, and so destroy the stuff previously obtained, which was called froth.

Arthur Howard Higgins.

Q. 332. What is the relative specific gravity of the mineral and the sand, about?

A. I think the specific gravity is about four and a half of the mineral, and it is about one and a half of the gangue.

Q. 333. Now, would you regard that operation as a carrying on of the Cattermole process?

A. No, I should not.

Q. 334. Now, in your operation you have 5% of oil on the mineral?

A. Oil on the ore.

Q. 335. Suppose you had diminished the percentage of the oil, how would that affect the operation?

A. The granules would have been smaller. It might have taken a longer time to perform the operation, but I think if I had the two up-casts, in one to take out the fine material and then follow by another agitation, and in another to take out the coarse, I think one could reduce the amount of oil very considerably and still get Cattermole granules.

Q. 336. Well, under the conditions which prevailed in this experiment, the use of a single up-cast, was or was not the proportion of oil that you used a very great proportion for the Cattermole process?

A. I think the result shows that the proportion was an excellent proportion to take for that purpose.

Q. 337. What is the method of deciding in any case the proper proportion for a given ore—proper oil proportion for a given ore for the carryng out of the Cattermole process?

Arthur Howard Higgins.

A. The result is always the criterion.

Q. 338. You determine it by tests?

A. Yes, one usually makes a few tests to see what proportions give the best results. Of course I am not considering now the economics of that proceeding.

Q. 339. But if you were to carry out the Cattermole process you would take everything into consideration and it would be a matter of test. Is that right?

A. Yes, it would.

Q. 340. Can you arrive at the proper proportion for a Cattermole process for a given ore as a matter of mathematics?

A. No, you can not, because he gives a proportion of oil as depending on no less than seven different factors. That is, he does not give the different rates at which these factors vary or the rate the oil varies with these factors, and it is quite impossible to calculate the amount of oil you should use. That must be determined by experiments.

Q. 341. Now, are you ready to carry out the experiments in accordance with the disclosure of the patent in suit?

A. Yes.

Q. 342. And you may state what you propose to do.

A. I propose to take 500 grams of the Butte & Superior ore that we received in March, 1917.

Q. 343. Received from the defendant or the defendant's representative?

A. Yes. To which—and which has been ground

to pass a 65 mesh screen, 2000 c.c. of water at 40° C., 5.8 c.c. of sulphuric acid, 0.55 c.c. of oleic acid.

Q. 344. And that is what per cent of the ore?

A. That is .1% or 2 pounds of oil to the ton of ore. And this should be agitated for about three minutes at about 850 or 900, in the same type of apparatus—

Q. 345. (Interrupting) Revolutions per minute?

A. Yes. In the same type of apparatus as the Cattermole was done in, the only difference being that the vessel is made in two parts so that the top can be slid over the bottom part and so shear off the froth which is obtained.

Q. 346. And what do you call that apparatus?

A. We call that the slide Gabbett.

Q. 347. What was the apparatus that you used in the Cattermole experiment? Was it a Gabbett in which the upper part did not slide off; is that correct?

A. Yes.

Q. 348. This sliding Gabbett, what does it resemble in the fact of the slidability of the upper part?

A. It resembles very much the slide machine in this particular instance.

Q. 349. But what will the agitator be in this Gabbett?

A. The agitator is a cone driven from the bottom of the machine instead of a cone driven from the top of the machine.

MR. WILLIAMS: The experiment is a failure. It is the first time that Mr. Higgins has made a failure.

Arthur Howard Higgins.

The belt was slipping on the machine and he did not get enough agitation.

Q. 350. How long will it take you to fix the machine, Mr. Higgins?

A. Ten or twelve minutes.

Q. 351. Now, what, if any, comment on the testimony that has been given relative to the plant in suit do you desire to make?

A. The chief comment I have to make is about the agitation. The agitation at the time of Cattermole was the most vigorous agitation which was being used in the art. Cattermole took an agitator from another art, and by increasing the speed to a very great extent he introduced into the metallurgical art the high speed agitation.

Q. 352. And what was that apparatus that Cattermole took from another art?

A. The cone mixer or the Gabbett mixer.

Q. 353. And how had that mixer been used before Cattermole used it?

A. It was used in the coal tar industry, to keep the coal tar in the still circulating from the bottom to the top or from the top to the bottom so that the tar did not set in the still and char during the distillation. The Gabbett was also used at slow speed in cyanide work, keeping the cyanide solution and the pulp in solution. There again it was used as a slow speed agitator.

Q. 354. And for the Cattermole process you say it was speeded up?

A. Yes, the speed was very much increased. Al-

though that increase of speed had the effect of introducing a much larger quantity of air into the solution or whatever was being dealt with, that was not any great defect in the Cattermole process, as long as the granules were properly and efficiently made.

Q. 355. So that with the use of the cone Gabbett in the Cattermole process as it was used there was such speed of agitation as to produce the introduction of considerable air into the pulp?

A. Yes, there was.

Q. 356. And in the Cattermole operation what was the effect of that air in the pulp.

A. The effect of the air on the large granules was absolutely none. There was no attachment at all; but where you got badly formed granules, or some of the granules badly broken, you might get some air bubbles sticking to the granules, and it would so be carried upwards in the upcast, generally in suspension, but still making a defect in the process.

Q. 357. So that the air worked against the process.

A. When it worked at all, it worked against the process, yes.

Q. 358. But nevertheless as the record shows, the Cattermole operations were carried out in the Gabbett up to the speed that the Gabbett attained, which was the same speed that was useful in the process of the patent in suit?

A. Yes; we used to run the Cattermole Gabbett at about 900 r. p. m., and that was the same speed with which we first used the process of the patent in suit.

Arthur Howard Higgins.

The patent in suit says in the example that the mixture is warmed and briskly agitated in a cone mixer or the like, as in the processes previously cited, and the processes previously cited are the two Cattermole specifications.

Q. 359. Which are referred to earlier in the specification in the patent in suit?

A. Yes.

Q. 360. As to the apparatus that is shown in the drawing figure 1 of the patent in suit, what is the function of the spitzkasten, by reason of the fact that it is divided into three parts, J-1, J-2 and J-3?

A. The function of that spitzkasten is to divide the tailings into three separate portions. In J-1 we get the coarsest; in J-2 something a little finer and J-3 the finest material.

Q. 361. What would you call that operation in metallurgy?

A. That is a classification of the tailings.

Q. 362. And the function of this spitzkasten is to classify the tailings, is that right?

A. Yes, that was provided for the classification of the tailings. The general class of ore which was treated at that time, particularly zinc ore and copper ore, was roughly thirty and forty mesh crushing, and the instructions here, beginning on page 2, line 102, it says: "If the ore is crushed to 90 mesh to the linear inch, the froth may contain 70 to 80 per cent," that crushing then was considered so fine that it was doubtful whether the profits of the operation would

sustain the cost of that much finer crushing; so that this spitzkasten would take out the coarse stuff and that could be returned to the crusher or dealt with by some other means. But that is not the apparatus that we need now with the fine crushing that is used at the present time.

Q. 363. The function of the spitzkasten as classifiers is utilized by reason of that sort of arrangement in the classifiers—is it merely a matter of settlement?

A. No; there is in each spigot or each point of the boxes, pipes with valves, so that you can supply washing water.

Q. 364. You might read from the description of the patent as to that?

A. On page 2, line 77: "The boxes are all filled with circuit water; the pulp from the vessel A is distributed horizontally from a flat trough, O, through the inlet K^1. The heavy sands and coarser particles of mineral sink into the first box J^1, from which they are led to a shaking table, a convex buddle or the like, to be treated as above described. The middlings or medium sands fall into the box J^2, and if they contain any mineral, may be returned for further treatment by agitation. The up current of the water from the taps N^1 and N^2 prevents the deposition of any slime in these boxes. The fine sands or gangue slimes settle in the last box J^3 from which they are discharged to waste or further treatment."

Q. 365. Now, in the operation of that apparatus, what effect do these up currents have; how strong are they?

Arthur Howard Higgins.

A. Well, those up currents in the boxes J-1 and J-2 would be very moderate flows of water, so that the water in that neck would displace the slime that was coming down through the swan-neck pipe, N-1 and N-2, so that in fact, if there is any upflow of cleaning water in the spitzkasten, the idea is only to remove form the discharge product the actual slimes.

Q. 366. So that as they are shown there, the up currents would not of necessity cause any upward flow of water in the spitzkasten, is that right?

A. They need not.

Q. 367. They would perform their function without doing that work, is that right?

A. Yes, they could be made to perform their function without making any flow of the water.

Q. 368. And this whole arrangement of classifying the gangue was an incident of the coarse crushing of the ore?

A. Yes.

Q. 369. And did the process of the patent in suit have any effect in the art on the matter of crushing the ore?

A. Oh, yes; the art is now chiefly concerned with crushing the ore extremely finely, even up to 100 and 150 mesh, whereas before the introduction of this process the general range of crushing was about 30 mesh as the finest.

WHEREUPON an adjournment was taken until 8:30 P. M. May 11th, 1917.

8:30 p. m. May 11, 1917.

DR. WILLIAM MASON GROSVENOR, being recalled and having been heretofore duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. WILLIAMS:

Q. 1. Please, now, explain the moving pictures you are about to exhibit.

(1)

A. "The strong direct attachment of unoiled or de-oiled mineral particles for air bubbles. Four sizes galena:

6—Milligrams

15—Milligrams

20—Milligrams

40—Milligrams.

The experiment shown is carried out in unmodified water with a substantially uncontaminated air bubble. The 6 mg., 15 mg., and 20 mg. particles have previously been oiled, but the excess of oil has been removed by prolonged bubbling of air, until repeated lifting of the particle on the free moving bubbles indicated the reduction of oil to a minute film comparable in thickness with the film of oil actually adsorbed on the surface of the particle. The 40 mg. particle has never been oiled.

We have here shown in one experiment the strong

William Mason Grosvenor.

direct attachment of the air bubble for both unoiled and deoiled mineral particles. The sizes are chosen for the following reasons: The 6 mg. galena particle illustrates the maximum oil lift which, according to my experiments, can be made with the captive bubble manipulated as gently as possible, provided there is actually applied to the surface of the mineral and the bubble an amount of oil materially in excess of that required to give a layer about thirty one-hundred-thousandths of an inch thick over the whole surface of the mineral particle. This thickness of layer would be approximately that produced on an 80 mesh ore containing 15% lead and 18% zinc as sulphides and showing a screen analysis about as follows:

+ 65= 3.5%
+100=27 %
+150=22.5%
+200=10.5%
—200=36.5%

with the weight of the oil in proportion to the mineral at about 8% of the weight of the mineral content. This layer will be shown to be sufficient to cause strong mutual adherence of the mineral particles to one another and will be called hereafter, for brevity, the Cattermole proportion of oil.

The 15 mg. particle is about the maximum weight that can be lifted with the utmost care if the oil layer is considerably reduced in thickness.

The 20 mg. particle illustrates the maximum weight

that can be lifted by a free moving bubble when the thickness of the layer of oil has been reduced to somewhere in the vicinity of one one-hundred-thousandths of an inch, possibly less, and the 40 mg. particle illustrates the maximum attachment of the captive bubble to very thoroughly deoiled or entirely unoiled mineral. All these measurements are made in the absence, as far as possible, of any soluble neral frothing agent.

It will be noted that the bubble is deformed or pulled out to a greater and greater extent by the increasing load placed upon it as each heavier particle is lifted; that there appears to be no fixed angle of contact between the particle and the mineral. In lifting the 40 mg. particle it will be noted that the lift is at first uncertain, and experience has taught me to associate this phenomenon with slight contamination either of the particle or of the bubble. As in this case the particle was entirely fresh and had never been handled, it indicates to me the very slightly contaminated condition of the bubble, possibly due to the previous contact with the other particles or to some film present on the surface of the bubble which had to be distributed in part upon the surface of the particle before lifting would occur. This phenomenon was seen in the lifting of the large aluminum particle before the court on Tuesday. At first the contamination of the aluminum surface was such, even though it had been washed, that it could not be lifted; even after careful rewashing it was necessary to ap-

ply and re-apply the bubble to the surface of the particle before the particle would lift. I believe this to have been due to impurity still remaining on the surface of the particle, because under laboratory conditions of cleanliness I have repeatedly been able to lift the same pieces of aluminum without any delay or hesitation.

Those four galena particles, therefore, are exhibited to give a sort of measure of the forces with which we have to deal under different conditions.

This view is largely magnified and in order that we may observe accurately what happens, the sharp jerks that are necessary to remove the 6 mg. particle, the less vigorous movement required to move the 16 mg. particle, and the still less vigorous movement necessary to separate the 20 mg. particle from the bubble are clearly apparent in the picture, and serve to indicate how a more violent shock, or some sudden movement is practically equivalent to a heavier particle.

(2)

OIL GLOBULE FAILS TO PICK UP EVEN LIGHT METALLIC PARTICLES, AIR BUBBLE PICKS UP SIMILAR PARTICLES MANY TIMES AS HEAVY.

The purpose of this picture is to illustrate the relative weakness of the oil attachment. There is no

question of the selectivity of the oil, or its adsorption on the surface of the mineral producing highly viscous, strong films. But where a larger amount of oil is used than that necessary to produce this minute adsorption layer, we immediately begin to deal with oil in bulk and the high viscosity and original surface tension of the film becomes modified and may quickly become an entirely secondary factor in determining the attachment of mineral to bubble. The oil globules therefore, may have excellent attachment and not necessarily any substantial lifting power. This experiment is shown with both aluminum punchings and with galena. The galena particle weighs 5 mg., the aluminum disc 16.7 mg. and for comparison of the direct air attachment unobstructed by oil there is shown similarly the action of the air bubble on a 30 mg. galena cube and an aluminum punching weighing 54 mgs. The size of the small galena cubes was .87 millimeters and the size of the other galena cube, 1.9 millimeters and calculation shows that the results with aluminum correspond in effective surface tension with the result shown by galena particles. In this case the air bubble is made during the taking of the picture and shows the expressing of the air from the ink dropper underneath the cup shaped glass bubble holder beneath the water. As an illustration of the slight affinity of air for the silicious materials of the gangue, note the slight attachment of the air bubble for the glass dropper when it is withdrawn. The strong attachment and easy

and sure lifting of the 30 mg. galena particle and the 54 mg. aluminum particle are in strong contrast with this lack of attachment to glass. When the aluminum punching is dropped it appears on the bottom as a round object because standing on its edge.

It was noted in the last picture that when the maximum weight is attached to an air bubble, the air bubble necks out to some extent at the point of attachment under the strain of its load. The high surface tension of the air-water surface, finally, closes up this neck and peels it away from the mineral particle. It will be observed that when the oil globule is being made under a bubble holder exactly as the air bubble was made and when the dropper full of oil is withdrawn from the globule there is a long thin necking out of the oil. The drawing out of this neck is clearly distinguished from the air because the far lower surface tension does not choke off the neck. In this case about 14 dynes per centimeter is the tension of the oil-water surface as compared with 73 or 75 dynes per centimeter tension of the unmodified air-water surface. It is therefore not surprising that the small galena particle is not lifted, and that as Prof. Bancroft stated, "the oil necks off because the cohesion of the oil is insufficient." We can not speak of the cohesion of the air and I do not think it clearly expresses the condition to speak of the cohesion of the oil because it is a fluid, even though somewhat more viscous than the air. My way of putting it would be that the oil-water surface was extremely weak as

compared with the air-water surface and that the strength of attachment of mineral to an oil globule or to an air bubble depends on surface tension. The weak surface tension between oil and water, was ineffective as shown in this picture. The oil breaks off, a portion remains with the particle and a portion with the bubble. One reason why it is difficult if not impossible to assign a precise limit, unless the exact size of the particle, size of the bubble and amount of oil on both is specified, will be apparent as we watch this necking off of the oil. If the particle is large and the amount of oil is small the necking off will tend to be prevented by the fact that the amount of oil does not furnish a long thin neck and that, therefore, the break in the surface must occur while the neck is short and thick. When it is short and thick the circum~~stance~~ference of the neck is much larger than that indicated in the picture. The size of the bubble is somewhat important in relation to the amount of oil because the bubble must be covered with a film of oil and the surface of the particle must be covered with a film of oil before there shall be excess of oil to furnish a short thick, or a long thin, neck of oil. Repeated examination of this necking off phenomenon and the amount of oil necessary to produce or permit it, convinces me that the general range within which this ~~visable~~ visibly occurs for oleic acid, corresponds to about 8.0% of oil as compared with the weight of the mineral and that other oils vary according to the character of the oil in this same general vicinity. It

William Mason Grosvenor.

will be apparent, therefore, that no amount of oil comparable with a film two five-hundred-thousandths of an inch thick is responsible for the change in the behavior which occurs when the layer of oil becomes about one hundred and fifty five-hundred-thousandths. In other words the adsorption film five hundred one-hundred-millionths is far too minute as compared with the layer which is critical or effective in stripping mineral from the bubble. It is only five hundred one-hundred-millionths as compared with thirty thousand one-hundred-millionths or about 1% in thickness of the oil layer which is critical in stripping the mineral from the bubble. The latter can not be regarded as being an adsorption layer.

(3)

AIR BUBBLES DO NOT READILY ATTACH THEMSELVES TO OIL GLOBULES AND HAVE SLIGHT IF ANY LIFTING POWER WHEN ATTACHED.

Again we see the air bubbles being made under the glass bubble holder and note the nearly spherical bubble due to surface tension, like the rubber skin of a balloon, only slightly flattened because of buoyancy against the cup of the bubble holder. We see the bubble lowered into contact with the galena cube weighing 40 mg. and the galena particle being lifted. In examining the successive pictures of the film with a magnifying glass the mineral particle appears to snatch

William Mason Grosvenor.

the surface of the bubble to itself on close approach of the bubble. There is only one picture in which partial contact may be observed even though the pictures succeed each other at a rate of 16 per second. We shall discuss later how wonderfully rapid these movements of bubble films actually are. Contact with the particle is secured by further lowering of bubble holder and the particle is easily raised. Then the oil globule is formed on the particle appearing as a transparent dome about one and one-half times the volume of the particle. The air bubble is formed and brought in contact with this oil globule and there is a remarkable difference noticeable between the readiness of attachment of the air to the oil globule as compared with the instant attachment shown for the galena particle. When attachment is made, however, we can note the subtile change in the appearance of the whole bubble as the oil flashes over it; the upper portion being a very minute film with the lens of oil described by Prof. Bancroft on the bottom of the bubble. As the bubble is raised we shall see the precise phenomena which he described in the necking off of the oil. No one would think of describing this particle of galena and this air bubble as directly attached and, knowing that the unmodified bubble or the modified bubble is easily capable of moving this galena particle, we are forced to believe that it is the presence or the absence of substantially direct attachment which determines an effective lifting or flotation of mineral.

William Mason Grosvenor.

The oil used is spindle oil, viscosity (Engler) 6 minutes, ~~48~~ 6 seconds at 20 degrees and specific gravity of the oil, 0.895 and the mineral 7.4. In this case one contact was made between the oil and the bubble before the oil flashed around and entrapped the bubble. The second illustration of the same thing will be shown with the particle already oiled on the bottom of the cell and in this case it will be seen that the bubble is brought in contact with the oil globule three times before attachment of the oil to the bubble is secured. It is clear, therefore, that attachment of air to oil is not as quick and effective as that of air to mineral. It is very clear that with this amount of oil the lack of cohesion (if we prefer to express it that way), or the weak surface tension of the oil, prevents attachment of the air bubble. What we have seen typifies exactly the condition of the mineral particle and an air bubble joined with sufficient oil to permit the mineral to move out away from the inner face of the film into a sufficient quantity of oil to surround the mineral particle and permit the particle to separate from the bubble film proper and be sustained in oil having the properties of oil in bulk.

(4)

AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL TO PRODUCE ADHESIVENESS.

(5)

AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL (COTTON SEED), to PRODUCE ADHESIVENESS.

Since we have seen that there is some amount of oil which will prevent direct attachment of mineral to the bubble, we are called upon to seek some indication of the line of demarcation at which the mineral ceases to become indirectly attached and becomes directly attached to the bubble film. A little thought, a moment's consideration, will convince one that if there is sufficient oil on the mineral to serve as a medium of attachment to another particle of mineral, there should be sufficient oil to serve as a medium of indirect attachment to an air bubble. A minute quantity of the oil will be required to supply the air bubble with its film, but even though the air bubble is thirty times the diameter of the particle and, therefore, possesses one thousand times the surface, the thickness of the film required by the bubble is only ten one-hundred-millionths of an inch, or sufficient to alter the thickness of the layer on the particle by about ten one-hundred-thousandths of an inch in thickness. For this rough comparison it makes no difference that the bubble is spherical and the particle is a cube. If the particle starts with a film about thirty one-hundred-thousandths thick (Cattermole proportions), it will still have left after coat-

William Mason Grosvenor.

ing the bubble, enough oil to furnish itself with a layer twenty one-hundred-thousandths thick or twenty thousand one-hundred-millionths or two thousand times as thick as the oil film on the surface of the bubble. So that it is important to observe whether under these conditions the drawing of the oil together (i. e., the reduction of the film on the particle from the remaining twenty one-hundred-thousandths to the adsorption layer) will furnish enough excess oil with that held to the upper surface of the mineral by adsorption and that on the bubble to produce an intermediate layer of oil between the mineral and the bubble, capable of necking off and producing indirect weak attachment.

Again we shall compare the unoiled aluminum disc with the two oiled aluminum particles; the former weighing 50 mg. and each of the latter weighing 25 mg. The two latter, however, had been oiled with cottonseed oil, specific gravity .92 and weighing .26 mg., about nine-tenths per cent of the weight of the aluminum particle, and producing a layer of oil about thirty one-hundred-thousandths of an inch thick on the surface of the aluminum. This layer on the surface of a material ground to eighty mesh will require between 4% and 8% of oil on the mineral by weight. It is seen that the air bubble peels off from the surface of the particle after substantial attachment and careful examination of the pictures highly magnified, shows that there is distinctly something between the air bubble and the mineral particle. This amount

of oil is sufficient to produce adhesiveness as we will show by the ability to pick up one oiled particle with the other and the excellent degree of adhesiveness that results.

(6)

AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL (OLEIC ACID) TO PRODUCE ADHESIVENESS.

Identical operations are shown with oleic acid. In both cases examination of the picture highly magnified permits us to see the taking of oil from the general surface of the particle as if by suction on the face of either the bubble or the other mineral particle, as the case may be. When adhesiveness is shown it is only during this contact and drawing oil over the particle that there is sufficient oil to be visible and when the particles are separated the oil disappears from sight.

(7)

THE UNLIMITED CARRYING POWER OF AIR BUBBLES AS COMPARED WITH OIL.

AIR BUBBLES IN WATER LIFT PIECES OF ALUMINUM ONE INCH IN DIAMETER, .05 INCH THICK.

The dual object of this experiment is to show first how great the carrying power of sufficiently large

air bubbles may be made if their load is suitable designed. The same aluminum piece is shown as was used on the 8th before the court. It is slightly over one inch in diameter, .05 inch thick and weighs about one and seven-eighths grams; it is just about the size of a twenty-five cent piece, but of course the aluminum is much lighter. Having exhibited the aluminum disc, the picture shows it being deposited on supports along the edge of the cell to prevent its sticking to the bottom of the cell. The large air bubble is then shown to descend upon the disc and a marked difference in the quick, complete attachment will be observed as compared with my first effort to lift the disc in court. This will serve to emphasize the necessity of cleanliness and the advantages of making photographic records of what takes place under laboratory conditions, which can be accurately governed in the respect of cleanliness or precise degree of contamination.

Attention is called in this case to the firmness with which the aluminum disc adheres to the bottom of the bubble, swaying from one side to the other and bumping against the side of the bubble holder. The question will probably be asked "why are results that require such extreme cleanliness or such precise degree of oiling as to make necessary the greatest laboratory precaution, of any interest to mill operations?" But this question answers itself instantly when we consider the enormous tonnage of material being treated and the relatively infinitesimal amount of opportunity

which the material has for becoming contaminated. It is a matter of common experience among technical men that far more precise results can frequently be obtained in handling tons than it is possible to secure in the laboratory handling grams. In manufacturing sulphuric acid for instance, the regular daily product of a number of factories with which I am acquainted, contains less than .0005% of arsenic, although there are considerable quantities of arsenic in the ore from which the acid is made. So small is the amount left by our regular commercial methods that new and special methods of analysis starting with a two pound sample of material had to be devised before we could determine the amount of arsenic which was present. Another point in this connection is that it takes days and sometimes weeks of continuous operation after starting up a new plant to wash out the systems and attain standard conditions, after which hundreds of tons of material going through in a day keep it washed out with a degree of completeness that no laboratory purification can approach. When, however, we begin to juggle with the plant, introducing impurities one day and omitting them the next, plant tests, just for this reason, frequently become less reliable than laboratory tests. It may take a week to overcome the advantage or disadvantage of one day's unusual operation, and my careful study of chemical manufacturing would lead me to expect that commercial flotation plants such as I have seen, when once contaminated by soluble frothing agent, might

William Mason Grosvenor.

require weeks of running without frothing agent before the benefit of that soluble frothing agent could be eliminated.

(8)

SAME ALUMINUM PIECE SUSPENDED BY A FINE THREAD LOWERED THROUGH WATER TO SHOW PLIABILITY OF THREAD.

In order to pass the same aluminum piece back and forth through the oil-water interface, as we propose to do next, it will have to be suspended on threads and to satisfy ourselves that these threads are not rigid, we lower the aluminum piece through the water and show the pliability of the threads and observe the way in which they sag or float freely of their own buoyancy suspended in the water.

(9)

SAME ALUMINUM PIECE LOWERED THROUH OIL LAYER ON WATER SHOWING ABSENCE OF OIL CARRYING POWER.

While this shows the inability of the oil-water interface to support the aluminum piece as did the air bubble, it is not by any means as conclusive as other experiments that are shown. The lesson of this picture is the adherence of oil and the enlarged necking off of the oil under any sufficient strain. This phenomenon is repeatedly seen elsewhere on a much

smaller scale but can here be observed with an enlargement and perfection of detail which can nowhere else be seen.

We see the disc descend through the interface between the upper layer of spindle oil which looks very dark because of its yellowness and optical opacity. As it meets the interface between the oil above and the water below, we have a fine opportunity to observe the different oil neck effects. As long as the disc is very close (relative to its diameter) to this interface, and the walls of the neck are straight, the circumference of the neck is practically the same as the entire line of attachment all around the disc. The weak surface tension of the oil-water interface, therefore, still has the whole circumference of the disc as its operating line across which it may exercise its lifting power.

Imagine now that we are looking at an enormously magnified picture and a minute mineral particle attached to a layer of oil around the bubble; imagine that the bubble had changed its direction with the swirl of the current produced by agitation in the pulp. In consequence of this the inertia of the particle would make it strain at the oil-water interface with its own tendency to continue moving in a straight line and not swing off on a curve. Imagine sufficient oil to permit the disc (or magnified particle) to drag out this interface. This allows the surface tension which is acting around as well as along.

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the neck of oil to counteract it (to decrease the diameter of this neck) and consequently decrease the circumference along which the lifting or sustaining force of surface tension can be operative. Since this contraction starts it is cumulative in effect. We have, therefore, vividly shown in this picture the reason for the somewhat sharp limit concerning which Mr. Scott inquired on cross examination Wednesday morning. It will be instantly seen that just as soon as there is enough oil to permit a particle to swing away and drag with it the oil-water interface, separating it from the oil-air interface and producing a neck of oil in bulk, that such a neck immediately tends to automatically reduce its own strength by constricting its diameter, thinning down to a point where its low surface tension can be exercised over the circumference which rapidly becomes negligible in strength. The lowering of this aluminum disc therefore makes clear in a way that nothing else in these pictures can do, the absence of oil carrying power and the reason for its absence, The billowing of the oil layer at the surface between the oil and water, with its slow movement, indicates the lack of strong surface tension to quickly restore a straight surface. This is also shown by the way the oil is carried down into the water and then the water is carried up into the oil as the disc passes back and forth through the interface. It seems to me we need no better explanation of Prof. Taggart's interesting experiment in which the

water disc dropped down from the bubble through a layer of oil. There is no reason for assuming very high viscosity of the interfacial film, particularly in view of the low viscosity of the interfacial film which was shown with his magnetic spider on the surface of water contaminated with oil alone. A better and more rational explanation why the discs are slow to return to spherical or globular form is a greatly reduced surface tension between the oil and the water and the great inertia of the water enclosed by this film as compared with the air or gas inside of the water bubble films and with which we unconsciously compare these little discs of oil.

(10)

WHEN AIR BUBBLES LIFTING METALLIC PARTICLES MEET THINNEST POSSIBLE OIL LAYER, THEY DROP THE PARTICLES.

Galena Particle 29 mg.	Small Galena Particles	Aluminum Particle 54 mg.

This same insecurity of the oil attachment, or support, for mineral particles entrapped within the oil is observed when bubbles carrying mineral particles are raised to the surface of water that is covered with thin film of oil. It may be said (and has been) that this showed nothing, because the bubbles burst when they met the surface and naturally could not hold the

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particle. In merely viewing this experiment as pictures rapidly projected on the screen for the sake of continuity, this may seem to be so because we can not accurately observe both bubble and particle at the same time. The camera has no such limitations. Any one who will take these pictures and examine them one by one with a magnifying glass will see certain evidence that in at least two cases the particle has completely left the bubble, and slid down on the oil-water interface before the bubble, now modified by its passage through the oil, has had time to burst. I know this is the case in two instances and it appears to be the case in all. This will be discussed in detail for each bubble as it is described ascending through the surface, and is excellent proof of the enormous superiority of photographic observations over mere ocular observations of an experiment. One picture succeeds another, one-sixteenth of a second apart, leaving no doubt as to what occurs or the way of its occurrence.

There is an enormous amount of detailed information as to just what happens, and which happens first, to be gained by the painstaking examination of this series of photographs at critical points with a magnifying glass of about 7 power. An ordinary reading glass is very convenient, but the Hasting Triplet 7X reveals, when applied to these pictures, a wonderful amount that would otherwise escape the eye.

The oil used was spindle oil in the thinnest possible layer that I could maintain on the surface of the water

in the cell. This being a layer and not a film, was of necessity thick enough to be visible, and therefore thick enough to evenly cover the surface by the enlargement of lenses, covering the droplets, in other words, a few hundredths of an inch thick.

The loads used for the bubbles were respectively a galena particle weighing 28 mg., about one-half as much as the air bubble would carry. In another case (the middle one) a number of small galena particles about 40 mesh, were used in the third case a single aluminum punching weighing 54 mg. (about one half what the air bubble would carry). A yellowish mineral oil of medium viscosity was chosen (the yellowishness to enable us to distinguish the oil from the water in the photographing) an oil of medium viscosity was used in order that the surface tension phenomenon could be seen without being too long delayed by great viscosity of the oil. It should be remembered that viscosity does not imply rigidity and that, therefore, the most minute forces will ultimately produce the same movement, if restrained only by viscosity, as the large forces would produce in a short time. Here again I wish to point out the distinction between the stabilizing of a bubble film by the introduction of viscous material which retards its breaking, as distinguished from the stabilizing of a bubble film by the presence of solid material from which the liquid may be generally removed and leave the bubble structure permanently outlined in the remaining solid material. The latter is not viscosity and for want of a scientific term to

apply to the phenomena which, so far as I am aware, had never been produced and requires description, such a bubble was called an armor-plated bubble. I have seen those bubbles after drying out remain for months. In fact, in one instance I examined a specimen of this dry froth in New York a year after it was removed from one of the beams in the Miami plant, put in a pill box and taken back to the laboratory without any special care. The way in which the mineral particles were interlocked and fitted into an arch, like the dome of a cathedral, and apparently cemented together into a permanent structure like soft pumice stone, was very impressive.

The floating film of oil in the picture appears to be much thicker than it really is because the surface of the water curves against the side of the vessel. Its actual thinness can be observed where it surrounds the stem of the bubble holder after they have been pushed down through it. It is interesting in this picture to see the effect of a quantity of oil sufficient to produce a thin layer on the surface and observe in what manner it would be fatal to air bubble flotation. One by one, the bubble holders are slowly raised to carry the bubbles through the oil layer. We see the galena particle raised to the surface, touch the oil layer and become invisible owing to the rapid movement of its fall, just one picture before the bubble is destroyed. This would not be wholly conclusive if we did not see other experiments and if we had not seen on the afternoon of the 8th, various kinds of mineral

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particles stripped from the bubble at the oil-water interface when the upper oil layer was so deep that the bubble had no opportunity to burst. In the next case of small mineral particles we can clearly see in examining the films that a portion of the load had completely separated from the bubble to hang in the oil film before the bubble burst and in the third case the aluminum particle may be seen in three successive stages of sliding down under the surface of the oil layer while the bubble is still in perfect condition. This illustrates the relative precision of observation of the moving picture camera as compared with even the trained observations of an expert like Professor Bancroft who testified that the bubbles burst before the particles drop. Another advantage is the permanently accurate record which these pictures give us. In Wilmington I stated with regard to the galena particle, what was my observation from seeing the pictures on the screen, page 1666, line 20, printed Appeal Record, that the galena particle was left with the oil for about one fourth of a second after the bubble passed through the surface. According to my experience it was entirely immaterial whether the bubble burst first or afterwards. Dr. Bancroft raised the question and I find a precise record of just what occurred by which I can correct his mistaken impression and my own uncertainty.

Likewise, in the case of fine particles, examination~~s~~ of the individual pictures shows that a few of them drop too quickly to be seen except by a minute change

William Mason Grosvenor.

in the pile of particles on the floor of the cell. Some of the others are shown to have settled down the oil slide before the bubble burst. Presumably those in the middle do not decide which way to slide off. After the bubble breaks they also move off slowly, seeking the lowest point on the oil film and gathering together in a clot in which they hang for a few seconds.

During this temporary suspension of the fine galena particles and while they are moving over one another within the oil film and concentrating their load at a point, let us observe the aluminum particle slide down to the lowest point on the oil film quickly draw the oil-water surface down into an oil neck and continue its fall almost without interruption to the bottom of the cell.

Here again individual examination of the pictures shows three or four successive stages of the slide down the oil film before the bubble bursts. Look quickly now to the point where the small galena particles were suspended. We see them gather themselves together drawing the oil-water surface further and further down until the critical condition is reached when the surface rapidly yields and the mineral particles (unattached to the air at the surface. separated from this air by a layer of oil) drag away the weak oil-water surface, and the mixed oil and mineral is dumped on the bottom in a sort of reverse waterspout. This shows us just how the oil layer becomes overloaded. It is what was described as overloading or breaking down of the Elmore bulk oil process. It shows exactly what happens in all

its stages and helps us to understand the weakness and unreliability of oil air water emulsion whenever the amount of oil is sufficient to prevent direct attachment of the mineral to the bubble.

(11)

MINUTE EXCESS OF OILY MINERAL FROTHING AGENT CAUSES AIR BUBBLES TO DROP METALLIC PARTICLE.

Galena Particle	Aluminum Particle

3-10 milligrams of oil applied outside bubble.

Galena Particle	Aluminum Particle

This experiment shows the effect of an oil globule meeting a loaded air bubble carrying a particle weighing 25 mg. (about one half of the maximum lift) suspended on the air bubble, the aluminum punching weighing 54 mg. is suspended to the air bubble on the other side of the cell. A minute excess of oily frothing agent in the form of a globule is to be brought in contact with each bubble. We shall observe the small curved capillary of glass containing oleic acid approaching the bubble. The trembling of the hand which carries the oiling capillary is clearly seen. We shall watch for the flash or change of complexion in the bubble when the oil actually makes contact with it, as would a small globule of oil stirring around in the mass of the ore pulp and meeting a loaded air bubble.

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This flash indicates the spreading of the ~~n~~monomolecular film and forming of the maximum stable film around the air bubble. Examining the pictures one by one the delay between the first flash and the movement of the oil globule from the point at which it was deposited, may be clearly seen and in my opinion represents the appreciable time required for the monomolecular flash of oil film six one hundredth millionths of an inch thick to gradually increase its thickness up to ten-one hundredths of an inch. When it becomes stable against the little oil globule and the oil globule becomes free to move ~~above~~ about over the film, we shall then see the globule slide down the side of the bubble (as Dr. Bancroft stated under the influence of gravity). In my opinion this indicates the effect of shifting of the film rather than gravity. It shows to a large extent the taking up by the film between the mineral and the air, of whatever excess oil there is on the bubble surface. With no mineral attached to the bubble, I have many times seen the oil globule linger where it was originally put, or slowly rise along the face of the bubble. I consider this film of oil on the inside of the bubble to act something like a pipe. It has a thickness of ten one hundred millionths of an inch and is stable because of attraction~~s~~ between its own molecules which prevents their separating or taking any excess oil from globules or lenses. Suppose we regard the globule of oil as a large soap bubble and the film as a very small soap bubble connected by a pipe to the large one. The

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high surface tension of the small bubble will make it shrink together until its walls touch and the air which it contains will be forced into and increase the size of the large one. In this case the walls of the small bubble may be considered to be the two absorption films on each side of the oil layer and when they have taken enough oil to complete them, they have a mutual attraction for one another which keeps the oil forced back into the relatively large globule having lower surface tension because of its relatively greater size. If we now hang a weight on one side of our smaller soap bubbles and thereby overcome its greater surface tension, the fluid (air) which fills the big soap bubble will be drawn through the connecting pipe into the small one, because now the surface tension of the big bubble is not overcome and may be regarded as being assisted by the suction produced when the weight is hung on the small bubble. Similarly the mineral particle hanging in this double film tends to drag the outer film or absorption layer away from the inner and can not do so unless there is an excess of oil to slide in (as oil in bulk between the two films of ~~the~~ oil in the film) to permit the two adsorption films on each side of the oil layer to be separated by oil. There is, however, an excess of oil in the globule attached to the side of the bubble and this excess turns into a film as fast as the dragging away on the mineral particle separates the two interfaces of the film in which it is hanging. The mechanism of this separation is probably in, part, a slight flow of oil in bulk between the two a~~b~~dsorption

layers, but is chiefly the dragging of the film itself toward the place on which the particle is pulling. This serves to thicken ~~of~~ the film at that point into a layer by converting the two adsorption films drawn to this point into bulk oil between ~~the~~ their films as fast as the globule is capable of converting itself into additional film. I have carried this experiment out many times. Always the globule seems to throw off the film in both directions above and below itself and, as the film on the under side is taken away and converted into bulk oil between the particle and the air, the globule is drawn downward until what is left of it joins this mass of bulk oil. If the globule is extremely small the particle does not let go until the globule reaches the edge of the area under tension. If the globule is large or if we slowly feed oil to the side of the bubble from the capillary, there is no such phenomenon and the bottom film appears to thicken into a layer as the particle drops off. In this case we shall see the globule move down the bubble, see the mineral dropping away from one side (approached by the globule) and see it finally let go of the bubble. The amount of oleic acid used was three tenths of a milligram or about 1% of the weight of the particle. The trembling of the hand makes it difficult to be sure of the size of the globule that is added to the bubble or even that only one globule has been added. The inestimable value of the photographic record every one sixteenth of a second is made clear on examining the pictures with a 7 X magnification. We can even measure with reasonable

accuracy the relative size of the particle and the globule and estimate from the size microscopically measured and from the specific gravities the figures given above within about 10%.

Similar phenomena are observable with the aluminum particle. In this case the particle appears to take up its oil through the film, as it is practically ready to drop off during the fraction of a second that the dropper is seen in actual contact with the bubble. The sharp outline of both aluminum and galena particles after they have come to rest on the bottom are the best evidence how little oil was required to strip them from the bubble. The accidental shaking of the aluminum particle by knocking the holder with the capillary is as fine an illustration of direct attachment, as the whole picture is of indirect attachment.

Thus we see how oil acts as a robber of air bubbles, slips in between them and the metal particles and destroys the powerful direct attachment.

(12)

AIR WILL NOT ATTACH TO MINERAL ENVELOPED IN OIL.

Finely ground mineral particles less than 200 mesh (.0029″ .005 mg.) are touched with air bubbles in pine oil, no lifting whatever.

We must, however, convince ourselves that air can have no attachment whatever for mineral enveloped in tangible quantities of oil, ~~upon~~ before this interpretation of

William Mason Grosvenor.

detachment shall be quite conclusive. To do this beyond question, we must satisfy ourselves that this is also true of fine dust. So we shall see in this picture minus 200 mesh galena containing dust of most minute size placed on the bottom of the cell filled with pine oil. The same experiment has been carried out with other oils and other mineral giving exactly the same results. The fineness of the dust is illustrated by the smoky appearance of the trail left by the forceps as they are entered into or withdrawn from the oil. We shall see the captive air bubble brought down repeatedly and firmly into as close a contact with this pile of dust as the surface films of oil on the dust and the bubble will permit. In doing this we exactly duplicate the condition of oiled mineral held in oil on the surface of an air bubble, when excess oil permits thickening of the film into a layer. The bubble is withdrawn without the faintest trace of attached mineral.

(13)

MAGNIFIED VIEW OF CLEAN AIR BUBBLE IN PINE OIL NO MINERAL ATTACHED.

To satisfy myself of the absence of such attached mineral, no matter how fine, I have repeatedly examined the bubble highly magnified, and show here a photograph of the illuminated under-surface of exactly the same bubble which you saw in the previous picture, taken immediately after it was withdrawn from the mineral. There could be nothing more conclusive than

this test, of the failure of mineral to remain in contact with the air bubble film, when the amount of oil permits the outer film at the oil-water surface to become so far removed from the bubble as to permit the mineral to stay at the oil-water interface and go away from the oil-air interface.

(14)

DE-OILING OF THE GALENA PARTICLES—KEROSENE RAPIDLY REMOVED. THREE SIZES SHOWN IN PINE OIL AND WATER.

6mg. 16mg. 20mg.

We saw in court on the 8th with what difficulty excess of oleic acid was removed from galena by air bubbles. We shall here see one of the peculiarities of kerosene which may have led to its selection as the oil with which to attempt flotation at high ratio of oil to minerals. We shall see clearly why excess of kerosene oil on the mineral is less harmful than other oils, because the excess is more readily eliminated from direct contact with the bubbles actually lifting the mineral, so that it may become a harmless excess instead of remaining a harmful one. For the experiment with oleic acid in court the 16 mg. particles was chosen. 20 mg. have been repeatedly de-oiled from oleic acid and lifted, but it takes more time. Here we shall see all three particles soaked with kerosene and having a considerable excess, placed on the cloth false bottom of the same cell and photographed while the air bub-

William Mason Grosvenor.

bles were passing over them just as we passed the air bubbles over the 16 mg. particle before the court. It is really remarkable to note the rapidity, amounting almost to suddenness, with which the first few bubbles snatch away the excess of kerosene. Kerosene behaves more like a liquid mineral than like a flotation oil both in its attachment to air and with respect to its inertness as a frothing agent. It is also peculiar in the high surface tension of its interface with water. Consequently, it requires a relatively large amount of kerosene or other mineral oil to bring about the dropping of mineral from the air bubble and it is possible to overload the process with a greater excess of kerosene than other oils, before this excess ceases to be merely useless and becomes positively harmful.

The relative effect of weight of particle is also here observed. It will be observed that 6 mgs. quickly become sufficiently clean to lift, that it takes more time and many more bubbles to lift the 16 mg. and requires still more time and far more bubbles to clean up the 20 mg. The experiment was carried out in water modified with 3½% of pine oil and the smaller bubbles produced in modified water can be clearly seen in comparing this picture with others I have made using only insoluble frothing oils. This difference is beautifully illustrated by the 20 mg. particle. He requires two and sometimes even three bubbles in pine oil water before he will lift whereas with oleic acid he takes but one larger bubble.

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(15-16-17-18-19)

MAGNIFIED VIEW OF DE-OILING 6 MG. PARTICLE FROM KEROSENE. THE RAPID REMOVAL OF OIL IS CLEARLY APPARENT, AFTER WHICH THE PARTICLE LIFTS WITH THE SECOND OR THIRD FREE AIR BUBBLE.

The magnified views were made immediately after the view just shown in the cell and supplied with oil by a dropper as was done before the court on the 8th inst. This shows another interesting difference between kerosene and some other oils. The kerosene does not seem to spread its film over the mineral particle as readily. We saw in court how the oleic acid placed on one side of the particle affected all sides of the particle and continued to do so for hours. The kerosene, though it attaches quite readily to the mineral, does not spread. This is probably due to the fact that water-kerosene has a much higher surface tension than water-oleic (or water-olive, or almost any other water-oil surface), and this higher water-oil surface tension holds it from spreading. So, these particles, having been once deoiled and reoiled under the water in the cell, are shown to be far more quickly cleaned up by the air bubbles than at first. This picture shows clearly the cause of something that puzzled me for a long time. When a particle has once been deoiled by air and carried to the surface by the bubble I thought it should continue to behave that way.

P. 4570, L. 10, after "the" insert "same cell and liquid. The particles were put back in the"

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It was not till such highly magnified pictures were taken that I found the particles falling to the bottom with easily visible quantities of oil on them picked up at the oily surface and brought down. Another peculiarity of kerosene can be seen comparing the magnified pictures of this kerosene with the oleic acid pictures of the same experiment. Owing to the high oil-water surface tension of the kerosene, more oil can be present at the junction between the bubble and mineral, without substantially interfering with attachment. In other words kerosene is peculiarily adapted to be present in considerable useless excess before becoming a harmful excess. Better results are obtained without the useless excess but it is not quickly injurious to attachment. This is seen in the pictures in one case when the bubble catches up a particle that still has an amount of kerosene that is visible when so largely magnifiied.

Nothing could be more conclusive of the vital and critical effect of necking off of oil, as the cause of dropping mineral in air froth flotation, than this correlation of effects actually obtained with those relative physical properties that common sense tells us should have such an effect.

(20)

AGITATION OF WATER UNMODIFIED BY A MINERAL FROTHING AGENT PRODUCES AIR BUBBLES WHICH COALESCE, RISE AND BURST. MINERAL FROTHING AGENTS PRODUCE SMALL AND PERSISTENT AIR BUBBLES.

"UNMODIFIED WATER".

Having seen the effect of oil as a robber of minerals from the air bubbles, we shall endeavor to get some insight into the complex phenomena which the process of air bubble flotation exhibits and which are permitted to stand clearly forth from obscurity only by the elimination of oil or by its reduction to the vanishing point so far as our senses and its effects of adher~~ane,~~ence etc., are concerned.

First we shall see the result of making air bubbles in pure or unmodified water and how instantaneously, when the agitation is stopped, the powerful surface tension films of the bubbles and masses of air draw them together, and they rise almost instantly to the surface.

The action of the air bubbles in unmodified water is very striking when the individual pictures are examined, particularly the magnifiied view, but this view gives us an exceedingly good impression of how great the forces must be, and how rapid their action, when all of that air is forced out of the water in such a brief space of time.

William Mason Grosvenor.

(21)

MAGNIFIED VIEW OF UNMODIFIED WATER.

Then we shall observe a magnified view of that action. We shall see what happens to these air bubbles. We shall see them rising at a rate reduced to about one-tenth of their true magnified rate of movement, because our pictures were taken at 120 per second, and we now observe them at about 12 per second. We shall note that even thus reduced the apparent velocity of their rise is great and likewise that, whenever two bubbles approach each other closely enough, there is a flash too quick for the eye to follow, even though we are now seeing it move only one-tenth as rapidly as actually occurred. After the flash there is but one bubble where formerly there were two. Coalescence has taken place with the swiftness and violence of an explosion.

I may say these pictures are all illuminated from behind, and that is why the bubbles look black. The appearance of hollowness is due to the reflection inside of the bubbles themselves (making a sort of light spot) in addition to which there are equatorial parts of bubbles, which are nearly parallel, so that the light goes through without serious distortion. The spark which was used in taking the pictures was located back of the cell, and the light was thrown through an optically clear passage, forming part of the circuit in the cell where these bubbles might pass up between the illuminating surface and the observing opening.

The pictures are running now something like a tenth of the speed ~~probably~~ at which they were taken, and it gives some idea of the riot that was actually going on in the bubbles. The currents in many parts of these pictures were moving downward at times, when the bubbles were trying to move upward, and we get a compromise movement. In some cases the larger bubbles tend to fall.

While the coalescence appears in the pictures to be fairly slow, it must be remembered that this is an ocular effect. The eye carries over, from the rate of approach of the bubbles, the impression that they coalesce at the same speed. The proof that this coalescence is enormously more rapid than the approach, is that we find a number of successive pictures, showing the approach, but never (so far have I been able to find) two pictures showing actual coalescence going on, and that makes the maximum period of coalescence 1/120 of a second. The actual time of coalescence must be far less than 1/120 of a second. How very much less it really is we can conjecture from an occasional picture that happens to be taken in the actual instant of coalescence. Such pictures, although the duration of the actual spark of illumination was less than 1/25,000 of a second, were not instantaneous enough to make the photograph clear. Careful study of these pictures, one by one, under the magnifying glass, shows the flow lines that always appear in ordinary photographs taken of quickly moving objects. When we consider that the ordinary photograph is

P. 4574, L. 9, after " tend " insert " to rise and the small bubbles tend "

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taken in about 1/35,000 of a second, and that these photographs are taken in something like 1/1000 of that time, the inconceivable swiftness with which the surface tension snaps two bubbles into one is dimly appreciated and the violent shock that would result to metallic particles suspended on the bubbles can well be understood. Judging from the flow lines of the pictures that we have, the period must be in the neighborhood of 1/16,000 of a second, as the actual coalescence time. It is difficult to believe that such minute action can be violent until we study the pictures in detail and see its amazing swiftness, like the flash of an electric spark. Among these pictures of coalescence, we find occasional pictures where three bubbles come very close together at the same time; then two of these coalesce and almost invariably the third (perhaps 1/100,000 of a second too late for its appointment) is thrown entirely out of the sphere of attraction by the explosive violence of the coalescence between the other two.

I do not think we can see that clearly in the films as they are run but when the pictures are examined under a magnifying glass, it can be seen very clearly in many cases.

A further confirmation of the extreme suddenness of this explosive coalescence may be obtained from the fact that only in about one case in a hundred where coalescence has been observed and studied do we happen to get a picture in the actual process of joining. The interval between pictures is 1/120 of a second.

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The duration of each picture is probably about 1/36,000 of a second, and the law of averages indicates that the actual duration of these coalescences cannot be much more than about 1/12,000 of a second.

The mineral particles suspended on the air bubbles in pure water would have about as much chance of surviving their attachment as a beetle hanging on a stick of exploding dynamite. At last one can appreciate what is radically wrong with pure water as a medium of mineral flotation.

(22)

WATER MODIFIED BY OLEIC ACID.

We shall now see clearly that the presence of a frothing agent makes an enormous difference in the behavior of air and water.

We shall now observe the effect of adding a minute quantity of oleic acid or mineral frothing agent of the first patent in suit.

Oleic acid has a modifying action that is indicated by the formation of smaller bubbles and masses of finely divided air, made up of minute bubbles, and the masses of air being apparent here that are entirely lacking in the unmodified water.

(23)

MAGNIFIED VIEW OF WATER MODIFIED BY OLEIC ACID.

We shall observe the magnified effect. There is

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the appearance at first sight of being slightly out of focus, but the larger of the bubbles that appear show that the focus is actually accurate, and that the cloudiness and haziness is due to minute masses of air being carried suspended through the liquid. These minute masses of air seem to aggregate themselves in groups and clots. The small bubbles hang on to the large ones, and are carried up or swept away, and are separated. The breaking up into these minute masses seems to be at least one of the important functions of the frothing agent. As we study these pictures, over a thousand of them, in the search for coalescence, we are forced to conclude that such is the case. This coalescence which makes any effective and suitable air entrainment difficult or impossible—this explosive coalescence which renders futile any effort of the mineral particles to adhere to the bubbles in pure water is notably absent. Even when large masses of air are specially introduced to observe their behavior, we find them first sweeping aside the smaller particles of air and then drawing the smaller particles into their wake without evidence of coalescence. The large masses do not grow in their progress, nor is there evidence of violent change of form similar to the explosive coalescence in pure water. The small bubbles of air gather into groups and masses without coalescence, and we can easily see how under these conditions mineral particles might be caught up and given the utmost opportunity to attach themselves to slowly growing air bubbles without the slightest violence or shock.

The amount of coalescence actually occurring is even smaller than appears in the projected view that we have here, because the habit of the eye fails to separate the bubbles after they meet. In a very large proportion of those cases, so far as I have been able to observe them, the bubbles meet and are swept away again. They pass around each other, and separate. Even then, supposing all the bubbles that appear there individually as bubbles shortly coalesce, the enormous amount of finely entrained air is clearly apparent.

(24)

WATER MODIFIED BY PINE OIL.

In this case 1-10 of 1% of pine oil is used alone showing the same action as when later used with kerosene.

Similar views of the effect of pine oil will show that it is closely related to phenol (which we shall see later) in its behavior as a frothing agent. These pictures were taken in the same general way, in the same type of air lift cell as was used for the other pictures.

(25)

MAGNIFIED VIEW WATER MODIFIED WITH PINE OIL.

Clearly shown typical smoky, or forest fire, effect like that of oleic acid.

The magnification in all cases was substantially

William Mason Grosvenor.

the same. The magnified pictures of pine oil alone, with kerosene, and with kerosene and Jones' Fuel oil (as well as of kerosene alone) were taken at much slower speed (about 40 pictures per second) and hence do not show up quite so well, but are strictly comparable among themselves and show the characteristic phenomena even though the bubbles seem to be rising more rapidly because the camera was run more slowly when tak~~en~~ing then.

(26)

KEROSENE OIL NOT A FROTHING AGENT.

Water containing first .05%, later ~~.040~~ 0.4%. Note bubbles rise quickly and cloudiness is due only to emulsified oil, not air.

This confirms the statements so frequently made by experts for the defense that kerosene is not a frothing agent. More than that, it shows clearly how easy it is to emulsify kerosene and how lasting is this emulsion when produced. Such oils in a pulp subjected to violent agitation may be expected to break away their excess from both mineral particles and bubbles without that excess appearing on the surface as an oily float. Such emulsified oil would be expected to carry along in the pulp. We have seen that globules of oil are not readily seized upon by air bubbles, and that oil globules may easily not attach themselves to mineral particles. It is not difficult to comprehend how a relatively large proportion of the excess of such oil added in flotation

might disappear as emulsified oil in the circuit water and turn up as oil in the tailing slimes where it had been caught and sedimented out in the settling of these slimes.

(27)

KEROSENE OIL NOT AERATING AGENT BUT IS ITSELF EMULSIFIED.

View of same undisturbed emulsion an hour later shows that the cloudiness is not due to air which would separate at the surface, but due to oil emulsion. The permanence of such an emulsion is here well shown by an hour's standing at complete rest. It would require the sedimenting action of alum, clay, or other finely divided powder such as gangue slimes, to carry down such minute particles of oil.

(28)

MAGNIFIED VIEW UNMODIFIED WATER IN PRESENCE OF KEROSENE OIL.

.05% at first, then 5%. Clearly shows large quick coalescing bubbles, proving absence of all modifying action.

This picture, taken just as the preceding magnified view of pine oil was taken, clearly establishes the statement that so far as concerns modifying the action of air and water to form minute bubbles, kerosene is wholly inert in the sense of harmless even to the amount of 5% on the weight of the water.

William Mason Grosvenor.

(29)

PINE OIL EXCELLENT FROTHING AGENT WITH KEROSENE OR ALONE.

First is shown the effect of 1/10 of 1% pine oil on the same kerosene emulsion, formation small bubbles on surface or froth, is not prevented by kerosene.

We may ask whether kerosene has any detrimental effect on frothing and the materials themselves visibly answer, No. Pine oil was added to the same kerosene emulsion that has been shown and we see that agitation now produces an entirely different result. When formed the bubbles are slightly more stable than with pine oil alone, as would be expected with the pseudo viscosity of the film produced by finely divided mineral present, or with the true viscosity of film, produced by liquid mineral.

(30)

MAGNIFIED VIEW OF WATER MODIFIED BY PINE OIL IN PRESENCE OF KEROSENE.

Here we see conclusively that the presence of the kerosene does not in any way interfere with the action of the pine oil in producing the "forest fire effect." It will be remembered that oleic as an insoluble frothing agent and cresol is a more soluble agent and phenol is a still more soluble agent, and each successively give increasingly fine smokes. So, for pine oil, we would expect something between oleic

and cresol, or phenol, and in fact we find the bubbles are not quite so small as for some of the other frothing agents.

(31)

MAGNIFIED VIEW OF WATER MODIFIED BY ~~PURE~~ PINE OIL IN PRESENCE OF KEROSENE AND JONES' FUEL OIL.

Here we have confirmation of the inertness of at least one other mineral oil product so far as frothing is concerned, in the substantially unchanged behavior of the pine oil water.

(32)

WATER MODIFIED BY PHENOL.

We shall ~~should~~ now observe the effect of carbolic acid or phenol.

We shall, after its addition, see the white smoke that takes the place of flashing masses of air bubbles, and when we see the magnified view we shall note that the phenol solution produces, if anything, even more minute sub-division of the air, and a far more smoky effect.

(33)

MAGNIFIED VIEW OF WATER MODIFIED BY PHENOL.

Phenol has a somewhat different appearance from the oleic acid, but the general character of the effect,

William Mason Grosvenor.

so far as the aeration of the water is concerned, is much like that of oleic, only there is a very great improvement in the fineness of subdivision.

As stated before, I think, when we look at these pictures, we must remember that the rate of taking, the time of exposure, the magnification were the same here as were used with the water unmodified, so that the air bubbles in the unmodified water as seen before are comparable in size by accurate measurement on the film, with the size of these infinitesimal particles of air that constitute the smoke. When this smoke is examined under a strong glass until we magnify it to the point of eliminating the picture entirely, and getting only the obscuring of detail by the granulation of the photographic emulsion necessary for a high speed film, such ~~and~~ magnification shows an increased clotting of the air but does not indicate in these ~~their~~ pictures any considerable number of bubbles of visible size included in the smoke.

The fluttering effect there is due to the spark, as it jumped from one to another side of the terminals. The scratches are due to points where the film slightly touched the camera, and moving at that ~~enormous~~ velocity almost anything would scratch the film.

(34)

WATER MODIFIED BY CRESOL.

We shall see all these general phenomena with cresol.

(35)

MAGNIFIED VIEW OF WATER MODIFIED BY CRESOL.

We see nearly the same effect, as was given by phenol, when magnified. There are minute differences in appearance. The magnification, it will be remembered, is the same that was used for the unmodified water, and all the others, and the time of exposure and other things are constant throughout this "magnified" series, (except for kerosene and pine oil)

With the cresol the effect is, as stated, much the same, but there appears to be a coarser granulation of smoke. At the same time, there is no practical comparison between the size of the bubbles as seen in unmodified water, and the particles as seen here. Some of the bubbles have stuck to the glass plate, as seen at the top, just to the right of the center, and it will be noted that they do not show any very material tendency to grow in size. The growth is extremely slow, even though they are battered and battered all the time by these multitudes of minute particles which are passing over them. There could be no better proof of the absence of coalescence.

(36)

WATER MODIFIED BY AMYL ACETATE.

We shall see in the same cell, as before, the clear agitation of the water unmodified, failing to entrain

any material quantity of air and when the amyl acetate is added, the smoky effect appears. Also a surface froth is seen when the agitation is stopped.

(37)

MAGNIFIED VIEW OF WATER MODIFIED BY AMYL ACETATE.

In a similar way we will examine the magnified view of water modified by amyl acetate, one of the soluble frothing agents characteristic of the second patent. This makes a similar smoky appearance of air entrained with water very much like that of phenol when viewed either with or without magnification, either as we see it now or as we saw it in the cell. There is nowhere any suggestion of violent coalescence of the bubble. Large masses of air were introduced again to see their sweeping effect, and it appears precisely the same as was seen before. The large bubbles do not apparently grow materially in volume.

(38)

WATER MODIFIED BY ACETIC ACID.

This is one of the best modifying agents we have and is an exceedingly good mineral frothing agent for certain substances. It seems excellently to point the lack of justification for calling the process of air froth flotation an oil process, for vinegar (4% acetic) is in no sense oil.

William Mason Grosvenor.

(39)

MAGNIFIED VIEW OF WATER MODIFIED BY ACETIC ACID.

Shows clearly the same characteristic subdivision of the air that is shown by other soluble frothing agents, and greater fineness of division than given by the oily frothing agents.

(40)

PRACTICAL RESULTS—AIR BUBBLES PRODUCED IN MODIFIED WATER PICK OUT METALLIC PARTICLES AND REJECT GANGUE PARTICLES.

This is the practical result of the scientific phenomena we have seen.

We shall view the practical results of the facts as indicated, in a sort of typical schematic ore separation, dependent upon the selectivity of air bubbles for metal over gangue, in a liquid containing about one fourth of one per cent of sulphuric acid and .02 per cent of cresol. We shall observe the behavior of our captive bubbles toward various mineral and gangue particles. Side by side on the bottom of the cell will be seen a particle of galena, of pyrite, and of blende on the one side; while, on the other will be seen a particle of quartz, one of feldspar, and one of calcite.

The weights of the non-metallic particles are less

William Mason Grosvenor.

than those of the metallic particles. The larger size and surface of the non-metallic particles typifying the gangue, give the air bubble the better chance for adhesion, should make the lifting power of the bubbles greater, and the surface tension line of application after adhesion greater with these non-metallic particles which are also of lesser specific gravity and should be relatively more easily floated.

We shall see the air bubbles seize upon the metallic particles, one after another, and reject the gangue particles one after another.

We first see the bubble approaching and raising the galena particle, and the galena particle then is shaken off by a jerk of the bubble holder. The air bubble will then repeat the performance in the case of the pyrite particle, and finally in the case of the blende.

This illustrates the powerful mineral lifting action of the bubble, and also shows clearly the fact that the particle, when once attached to the bubble, may be swung around and agitated to a truly remarkable extent (when the weight of these particles is considered) without detaching it. The air bubble will then be given an even greater opportunity to attach itself to each of the gangue particles. Having just picked up the galena pyrite and blende, we try the quartz as carefully as possible and fail to secure any lifting. The air bubble is carefully and completely brought in contact with the particle of quartz, brought clear down over it, and there is scarcely a trace of that

lingering adhesion; no visible evidence of strong attachment; no elongation of the bubble. We then proceed to the feldspar with a like result, and then to the calcite. The same painstaking care fails to secure the lifting of any one of the particles of quartz, feldspar or calcite typical of gangue particles.

It will be noticed that there is no such drawing out of the bubble or apparent effort of straining to lift, because there is no considerable adhesion.

(41)

OIL FROTHS.

We shall now examine the oil emulsion froth made with sufficient quantity of oil to entrap mineral and air (and largely magnified) to see whereof it is made and how it behaves. Although, as has been stated, the oil froths appear superficially not unlike air froths, we shall see the structure of the oil globules each entrapping the mineral particles. They lie the one over the other, separated by thin films of water, frequently entraining (within the globule itself, or between the globules) loosely held bubbles of air, which serve to give it an uncertain mass sponginess and an uncertain buoyancy.

This is an oil froth, in which air bubbles are apparent. It is being pressed and shifted between glass plates illuminated from the back ~~bottom,~~ so as to show the air, oil and water (the expelled part being chiefly air which comes out from between the oil masses) The

William Mason Grosvenor.

oil masses continue to hold the mineral, but as the air is pressed out by any jar or shaking or any of the things which would in practice occur in the separation of a froth, the air leaves the oil owing to lack of adhesion of air for oil. Owing to the fact that the mineral is enclosed in the oil, and out of contact with the air, finally the whole mass breaks away and settles. There are a few stray objects going back up with oil attached to them, either a bubble of air entrapped by a mass of oil, or possibly a bubble attached loosely to the outside of an oiled mineral granule. An attachment of that character, as has been repeatedly observed with the air bubbles which are attached to the outside of such oil globules, is loose and is easily destroyed by shaking, agitation on stirring.

The mineral held within the globule itself is buoyed up partly by the oil and partly by air entrained either within the globule or between the globules.

We have seen how slight an attachment air has for oil masses, and we have seen how slight an attachment air has for mineral particles when covered by oil. We have now observed (when this oil froth was gently moved), how the air bubbles slip out through the masses of oil, and escape, carrying with them relatively little mineral, because the mineral is coated with oil, and has no substantial attachment for the air bubbles.

William Mason Grosvenor.

(42)

AIR FROTHS.

In contradistinction to the oil froth, we shall see the air froth, and observe the different behavior of the mineral particles towards the clear masses, which are air bubbles. The large dark masses are coated air bubbles overlying one another. You can see, on these lower bubbles (for instance this one almost in the center) —that as the movement of the glass plates occurs, it seems to be elastic, like a rubber ball, and, being illuminated from the rear, the granulation of the mineral over the bubbles is very clearly observable. They and the mineral attached to their surfaces constitute the great bulk of the froth. There are no slippery masses of weakly attached oil. We shall see the metallic particles fringing the clear openings of air whenever we get a chance to look through the bubbles. We shall observe, as the froth is manipulated between the glass plate the buoyancy and power of air froth flotation in spite of the severe and repeated manipulations. We see how the bubbles move and expand or contract as the mass is manipulated, and we shall see them maintain their firm grip on the mineral particles held by direct attachment.

The oil froths and air froths may superficially appear not unlike. Critically examined, they are essentially different. The air froths are technical effects incomparably superior and radically different, both in practical result and in underlying principles.

P. 4590, L. 28, after "froths" insert "of the patent in suit"

William Mason Grosvenor.

Some of the mineral can, of course, be detached from the air bubbles. It falls, as mineral always will fall, from any froth, when severely manipulated, but the froth, as a froth, remains floating.

A severe manipulation is used in this case, very much more severe than was used before with the oil froth. When the air comes back up, there are lines of mineral particles picked up and brought up with air bubbles. You see here (indicating) the mineral particles drawn up. Those masses coming in are air bubbles carrying on the under surface here (indicating) the attached mineral, and it is a clear illustration of the difference in behavior of the two froths in all operations to which they are likely to be commercially subjected. The oil froths hold the mineral in the oil, and subject to all the weaknesses of attachment of oil with respect to air. The air froth holds the mineral tightly attached to the surface of the air bubble itself, and, if circumstances permit, these air bubbles are capable of building up a froth structure. If circumstances are not such as to permit the building up of heavy, enormously mineralized froth structure, the result will be that the bubbles will go ahead and carry the mineral, will perform their function and carry out the characteristic process of air froths. Some of the superficial phenomena may be disguised, but when we examine how they behave in detail, there is that characteristic bubble action.

Arthur Howard Higgins.

Q. 374. Dr. Sadtler in his testimony made a brief reference to patent No. 793,808, issued to Sulman and Picard in July, 1905, which appears at page 724 of the record for the defendant in the Hyde case. He quoted from page 1, lines 65 to 79 as a description of gaseous flotation. What have you to say as to the kind of gaseous flotation which was described in this patent 793,808.

A. The kind of gaseous flotation described in this patent is the attachment of the gaseous bubble to such oil moistened mineral so that the bubble carries the mineral up to the surface of the water. There the bubble bursts One of two things happens to the mineral: It either sinks or floats on the surface of the water, just like the greased needle does, which is generally termed "skin flotation." There is in this patent no disclosure of any froth whatever. The froth could not possibly be obtained without the employment of gaseous bubbles. The specification in line 93, page 1, says: "It is therefore unnecessary in some instances to employ gaseous bubbles to effect flotation." The three examples of the patent illustrated in the drawing also result in the flotation of mineral by the skin flotation process.

Q. 375. You have at times used the expression "surface tension flotation." What is the meaning of that in the art?

A. That has the same meaning as the skin flotation term.

Q. 376. Then I believe there is a term sometimes

Arthur Howard Higgins.

used in this case, "film flotation." Is or is not that descriptive of the skin flotation?

A. Yes, that is a synonym.

Q. 377. Are you familiar with patent No. 962,678?

A. Yes, I am.

Q. 378. By what name is that patent usually known?

A. The solution patent.

Q. 379. Dr. Sadtler has testified that this patent discloses a process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of a mineral forthing agent, and agitating the mixture to form a froth and separating the froth. Are you in agreement with Dr. Sadtler in that answer?

A. Yes, I am.

Q. 380. What is the specific soluble frothing agent disclosed in this patent 962,678?

A. Amyl acetate is the soluble frothing agent mentioned.

Q. 381. Is phenol mentioned as one of the soluble frothing agents?

A. Yes, phenol and its homologues, benzoic, valerianic and lactic acids; acetones and other ketones, such as camphor.

Q. 382. Are you ready to carry out an experiment in accordance with the disclosures of this patent?

A. Yes.

Q. 383. And will you first follow the specific disclosures of the patent, using amyl acetate?

A. If you wish.

Q. 384. Describe the experiment that you are about to do.

MR. KREMER: We object to this for the reason that it is incompetent, irrelevant and immaterial for any purpose whatsoever. We object to the experiment or any further testimony with reference to this patent. It tends to prove no issue in the case. I don't understand the purpose of it. The witness was asked if he agreed with Dr. Sadtler; that Dr. Sadtler mentioned the patent, and he said "Yes." There is no controversy. May I inquire the purpose, Mr. Williams?

MR WILLIAMS: Yes. The explanation of the operations that have been carried on by the defendant and others with the employment of large quantities of inert oils is partly to be found in the fact that in all of these operations a soluble frothing agent is employed. The soluble frothing agents exercise a peculiar co-operation with the inert oil. We have exhibited the interior structure, you might say, of the kind of bubble-forming operation which characterizes the soluble frothing agents, and we propose now to show the operation of the soluble frothing agents so that your honor may understand. We deem it to be important, by way of explanation of these operations alleged to represent the prior art, and in fact involving the process of the patent in suit and something else, and we propose to show, as far as possible, what that something else is.

MR. KREMER: On the statement of counsel we renew our objection, adding the additional objection

that there is absolutely nothing that has been testified to with reference to the existence of a soluble frothing agent in the prior art, and that there is nothing in the patent in suit which would justify the introduction of any such testimony. That is the subject matter of another suit recently filed in this court, and has no place in this trial. It does not tend to prove anything. There is no limitiaton in the patent in suit upon the use of anything other than the reagents specified in that patent and within the quantities that are specified.

MR. WILLIAMS: Just briefly. The defendant has introduced into this case experiments with frothing agents in solution. Every large scale operation carried on under any working conditions has been characterized by the presence of those soluble frothing agents, and the defendant having brought it in, we wish to explain it. Of course the question as to whether or not the defendant is infringing that patent is entirely excluded from this suit. We do not intend to go into that and we have not gone into it.

THE COURT: Has it appeared to the court that these experiments of the defendant, or their working operations, have been, as you now say, conducted with soluble frothing agents, or is that something the court is to take judicial notice of?

MR. WILLIAMS: I think it has quite well appeared that phenol, which is present in all wood tars and coal tars, has been used in these experiments, and the witnesses for the defendant have admitted that

phenol has been present in these wood tars and coal tars that they have used. A witness for the defendant has admitted that pine oil is partly soluble, and these experiments or these operations are all characterized by the presence of either creosote, wood tar, coal tar or pine oil, so that it has appeared that all these operations involve the use of frothing agents in solution, or soluble frothing agents.

Prof. Bancroft, I might say, also did experiments with acetic acid and alcohol, illustrating this operation with soluble frothing agents. It seems to me the condition of the record is such that your honor has been informed and that the defendant has injected the soluble frothing agents into the case.

MR. KREMER: If it is not disputed, as you seem to say, what is the relevancy of this testimony?

MR. WILLIAMS: We wish to explain the action of soluble frothing agents.

MR. KREMER: If that is not in dispute—Certainly by your own statement you admit that there is nothing in dispute.

THE COURT: Is it a question in this case somewhere whether oil in amounts above 1% is or is not an infringement of the patent? Is that question likely to arise and is it likely to be a contention that it is, and that amounts of oil above one per cent are to be accounted for on the theory of inert oil and some soluble frothing agents? If so, perhaps this is admissible. However, if there have been experiments, and there have been with alcohol at least, I will allow

Arthur Howard Higgins.

this experiment to be made, and if it be entitled to no consideration, the court will give it none in making up its decision. The objection will be overruled.

Defendant excepted.

MR. WILLIAMS: For the purpose of abbreviating the experiment I will ask you to perform the experiment with phenol?

A. Yes, that can be done.

Q. 385. And will you describe what you will do with phenol, as that is a specific thing that the experiment testified to by the defendant have used.

A. I shall take 2000 c.c. of water at about 40° C., dissolve in that 1.87 c.c. of phenol, making .1 per cent of phenol in the solution, add to that 4.5 c.c. of sulphuric acid. After a short agitation to mix the material, I shall put in 400 gms. of Broken Hill tailings crushed to 100 mesh and agitate for five minutes at about 850 r. p. m.

Q. 386. And as to the result so far as you will see it in the Gabbett, will that or will that not be substantially the same as of amyl acetate, the specific disclosure in this patent?

A. It will be substantially the same.

MR. WILLIAMS: I would like your honor to observe the operation of the Gabbett with nothing but pure water in it. If your honor will look down you will see that the vortex opens down to the very bottom of the vessel, and you now see the bubbles such as pure water produces, the large bubbles that coalesce and break, unmodified water bubbles.

THE WITNESS: I have now added the sulphuric acid.

Q. 387. Is there any difference in the bubble formation as a result of the addition of the sulphuric acid?

A. No, it is just the same.

Q. 388. Is sulphuric acid a mineral frothing agent?

A. No, it is not.

Q. 389. Now, please state what you are about to add?

A. I am about to add now 1.87 c.c. of melted phenol.

MR. WILLIAMS: I will ask your honor to observe the immediate change in the bubble formation from the addition of the soluble frothing agent, the different appearance of the bubbles and the clouded effect.

THE WITNESS: I now add 400 gms. Broken Hill tailings crushed through 100 mesh.

Q. 390. MR. KREMER: What is the degree of agitation?

A. Now, about 850 r. p. m.

Q. 391. MR. KREMER: What was it before you put in the phenol?

A. About 600.

Q. 392. MR. KREMER: Why did you increase it?

A. The lower speed was merely to make the solution of the phenol effective. That doesn't require any powerful agitation.

Q. 393. MR. WILLIAMS: Have you checked up the number of revolutions, Mr. Higgins?

Arthur Howard Higgins.

A. Yes. The motor is running about 80 r. p. m. too many, and that will make about 70 revolutions too many in the cone, makes probably about 900. I think we might stop at the end of four minutes so as to take off the effect of the extra speed.

Q. 394. What was the actual time of agitation?

A. Four minutes and a quarter.

Q. 395. Now, what you have obtained as a result of this operation?

A. About an inch and a half or inch and three-quarters of good froth, and very clean tailings. There is two inches of froth.

MR. WILLIAMS: Will your honor observe the tailings? They are settling now.

Q. 396. Now, will you remove the froth so that it can be separated and assayed?

A. Yes.

Q. 397. THE COURT: What is the ordinary name for phenol, carbolic acid?

A. Carbolic acid.

Q. 398. What sort of a material is phenol?

A. Phenol is a crystalized solid which melts at about 104° F., just a little higher than the temperature of the body. It dissolves to the extent of about 6 per cent in water, and the addition of a little water to the phenol makes it into a liquid. The material which we use was made liquid by melting it, that is by raising the temperature above 104° F. When it is dissolved in water in the proportion given in the patent

and even less, it makes an excellent mineral frothing agent.

Q. 399. What is your experience in the use of phenol as to whether or not an excess of phenol above the minimum required for mineral froth production but below the point at which it will not dissolve, effects the mineral frothing operation?

A. There is no difference whatever in the result or in the way in which the results occur; that is to say it does not happen any quicker or any slower.

Q. 400. The phenol when used in soluble proportions is it or is it not precipitated upon the metallic particles in the operation?

A. No, the phenol is found in the solution, not on the particles.

Q. 401. At the conclusion of the operation you did not find the phenol on the particle?

A. No, only such phenol as is in the water that is contaminating the particle.

Q. 402. So that the solution still contains the phenol?

A. The solution still contains the phenol and may be used over and over again.

Q. 403. And in that respect how does it compare with the insoluble oil frothing agent? Where do you find that at the end of the operation?

A. That oil is found at the end of the operation on the concentrate chiefly. A very small portion may be found in the tailings, but the water is particularly free from it and is no longer useful as a frothing agent.

Arthur Howard Higgins.

That makes a big contrast in the solution patent where the frothing agent remains in the solution and the solution can be used over again usefully.

Q. 404. Now, when you employ an oil or insoluble frothing agent, are there any conditions under which the gangue uses oil or consumes oil?

A. Oh, yes. It depends a good deal on the nature of the gangue and on the nature of the reagent that was put in to keep the oil off the gangue. The use of sulphuric acid is specifically for the purpose of preventing the oil from attaching itself to the gangue, and if insufficient is used of course some of the oil becomes wasted in this way.

Q. 405. What is the effect of a clay gangue?

A. It is very difficult to prevent clay from absorbing oil. Frequently the presence of the acid is insufficient, unless the acid happens to be in very strong solution.

Q. 406. When oil is absorbed by the clay or other gangue, has it any further utility in the process?

A. None whatever; in that condition it is absolutely useless.

Q. 407. What has been your experience with kerosene as a mineral frothing agent?

A. Kerosene is not a mineral frothing agent.

Q. 408. Are you ready to show that by experiment?

A. Yes.

Q. 409. Describe the experiment that you are about to do.

Arthur Howard Higgins.

A. I shall take 250 c.c. of water at about 40° C., and add to that 60 gms. of Butte & Superior ore handed to us by Mr. Dosenbach on the 25th of April .16 c.c. of sulphuric acid, being 8 lbs. to the ton of ore; and .15 c.c. of copper sulphate solution, which we obtained from the Butte & Superior plant on the 29th of April. I shall agitate that for half a minute, then we will add thereto .075 c.c. of kerosene, which is 2 lbs. to the ton, and agitate the mixture for two minutes, and it will be seen that there is no froth.

Q. 410. What is the apparatus in which you will carry on the experiment?

A. A bar mixer similar to the bar mixer used by Mr. Phillips. The agitator in this bar mixer runs practically the same speed as his did, which is between nine and ten thousand revolutions a minute.

Q. 411. Did you make that determination with Mr. Phillips' bar mixer?

A. I measured that one at 9500, and this one about 9800.

MR. WILLIAMS: Mr. Phillips was a little wrong in his estimate.

Q. 412. Can you give me some idea of the peripheral speed of the agitator in the bar mixer?

A. It is about 1800 peripheral feet per minute.

Q. 413. What are you putting in now, Mr. Higgins?

A. The kerosene.

Q. 414. What kind of kerosene is it?

A. It is kerosene that we bought here at one of

Arthur Howard Higgins.

Lutey's stores in Butte. I took the specific gravity of the kerosene at .82.

(Experiment performed.)

Q. 415. Now how long was the agitation done?

A. Two minutes.

Q. 416. And what is the result?

A. Everything is sunken; there are two or three bubbles on the surface—three—four I see. This is two pounds to the ton, or one-tenth of one per cent of oil. Now, we will add to that two pounds to the ton of pine oil, which is .07 c.c., and re-agitate two minutes.

Q. 417. Is that the settlement of the slimes?

A. Yes, that is the slime settling.

Q. 418. Is there enough kerosene there to show as a layer?

A. No.

(Re-agitation performed.)

Q. 419. Now, what have you produced as the result of adding one-tenth of one per cent of pine oil and re-agitating for two minutes?

A. A mineral-laden froth floating on the surface of the pulp, and a fairly clean tailing sunk to the bottom.

Q. 420. BY THE COURT: Would it have been any different without the kerosene?

A. Possibly it might be a little less. The coarser material has a tendency to fall out in the absence of sufficient oil to keep it there. We could get the same result with about four pounds of pine oil.

Q. 421. BY MR. SCOTT: You mean that the kerosene helps to keep the mineral from falling out of the froth?

A. Yes.

Q. 422. MR. WILLIAMS: Does the kerosene assist in the froth formation?

A. In small quantities it stabilizes the froth and prevents what we call showering, that is, the dropping out of the coarser particles from the froth.

Q. 423. State whether or not a mixture of kerosene and Jones' oil is an efficient froth froducer.

A. It is not, and I would like to show a similar experiment, showing that the Jones' mixture with kerosene does not make a froth, while the addition of pine oil brings up the froth.

Q. 424. Describe the experiment that you are about to do.

A. I shall take, as before, 250 c.c. of water at 40° C.; 60 gms. of Butte & Superior ore handed to us by Mr. Dosenbach on the 25th of April; .16 c.c. of sulphuric acid; .15 c.c of copper sulphate solution we obtained from the Butte & Superior plant. To that I shall add .61 c.c. of Jones' heavy mineral flotation oil, purchased by us from the Jones Company in St. Louis, mixed with Mineral Separation kerosene that we purchased from Lutey's in the ratio of 70 gms. of Jones' oil to 12 gms. of kerosene. The specific gravity of the mixture is .88. The pulp will be agitated for four minutes and the result observed.

Arthur Howard Higgins.

Q. 425. What do you mean when you said "Mineral Separation" kerosene?

A. Well, just as a distinction from anything that was given to us by the other side.

Q. 426. And this you purchased where?

A. At Lutey's store.

Q. 427. MR. SCOTT: I would like to have you look at the settlings of the gangue in this jar, and ask you if that isn't comparatively—and ask you if in that comparatively quick and well defined settlement you find evidence of a clay gangue you have spoken of?

A. That heavy clayey gangue is rapidly settling due to the flocculation by absorption of oil. That is a very common occurrence and is well recognized by metallurgists who have anything to do with this kind of operation.

Q. 428. You mean the oil is a usual flocculator? Is it used for that purpose?

A. No, I don't think so, not used purposely for flocculating clay slimes. Of course, clay rapidly absorbs oil, and it is well known that such occurs, and large deposits are found with solidified clay with the oil absorbed, known as oily shales and that kind of thing.

Q. 429. How would you describe the condition of the tailing here, consolidated or colloid?

A. I am not an authority on colloids. As for being colloids, my understanding of a colloid is that it is so near the solution it don't settle like that, although I do not pretend to be an authority on colloids.

Q. 430. MR. WILLIAMS: What is actually taking place in this jar now?

A. Settlement of the slimes.

Q. 431. A settlement under what condition?

A. The flocculated slime is settling through a very small quantity of slime that is not flocculated. The unflocculated slime renders the water slightly opaque, whereas the flocculated slime is coming down in a heavy layer.

Q. 432. So that it almost looks as though it were solid sand up to the point where it is going down you mean?

A. Yes. That condition can be brought about by the addition of various things to the ore.

Q. 433. MR. SCOTT: Isn't it a fact, Mr. Higgins, that if you simply stirred this pulp without any oil at all but simply with the same sulphide acid—you have sulphuric acid in there?

A. Yes.

Q. 434. Wouldn't those tailings settle just as quickly as they have settled?

A. Not quite so quickly, in my opinion. I should like to observe that this ore was handed to us by Mr. Dosenbach to repeat Mr. Phillip's experiment with, and is extremely unusual in the fact that it contains alkali which is soluble in water. In my opinion the presence of that alkali would have a tendency to increase that flocculation and render it more rapidly settling. The ore that you gave us in March, 1912, or 13 does not contain any alkali soluble in water, neither does the

Arthur Howard Higgins.

ore which we received here in March, 1917. The reason I used that particular ore was that I am not satisfied that the ore we received here in March, 1917, represents the ore that is being treated in the plant, whereas it is fair to assume that as they used it in their experiments that it is very natural that we needn't suspect it.

Q. 435. MR. SCOTT: Is it usual, Mr. Higgins, to get ore running identically the same in analysis, day after day, month after month, and year after year, from any mine?

A. It is quite unusual, but on the other hand it is something new to me to find ore coming out of the mine with alkali in it.

Q. 436. Have you made an acid or alkali determination of this ore?

A. I only have determined the presence of the alkali; I have not determined the quantity.

Q. 437. Used litmus paper?

A. No. Mixing the ore with water, distilled water, and then treated that with phenol phthalein, which gives a deep red color in the presence of alkali.

Q. 438. Isn't it a fact that you get an acid or alkaline reaction of almost any ore with a delicate test of that kind?

A. No, the same water shows deep blue to litmus, neutral litmus, which also is an indication for alkali, and it is not my experience that ores do contain naturally alkali material.

Arthur Howard Higgins.

Q. 439. MR. SCOTT: Is that acid now?

A. No, it is neutral.

MR. KENYON: It is stipulated that the several instruments in writing referred to in the supplemental bill of complaint in paragraph 3 thereof, and copies of which are annexed to said supplemental bill of complaint as Exhibit "A" and Exhibit "B" were executed and delivered as there alleged, and that said contracts were fully executed as there alleged, and particularly at the times alleged in said paragraph 3.

MR. KREMER: That is satisfactory.

THE COURT: The record may show.

MR. KREMER: That is all subject to the one objection to the supplemental bill, as to its general competency. There is a general objection interposed there and we do not want to waive that objection.

Q. 440. MR. WILLIAMS: Mr. Higgins, when you described the ore that you are going to use in this experiment, you did not tell us what it was given to you as. Was it or was it not the same ore that was used in Mr. Phillips' experiment?

A. That is what I understood. That is what I asked for from Mr. Do~~x~~senbach, and I understood we got it.

Q. 441. That is not the same specimen that was given to you at that time?

A. No, we used that.

Q. 442. But a larger specimen that you asked Mr. Dosenbach to give you and of the same ore? Is that right.

Arthur Howard Higgins.

A. Yes.

Q. 443. That Mr. Phillips used in his kerosene froth?

A. Yes.

Q. 444. Have you told us the proportion of oil to ore in this experiment that you are about to carry on?

A. No. That is 82 per cent of 22 pounds to the ton. Later we shall add the balance of the 22 pounds which will be 18 per cent of 22 pounds, of pine oil.

THE COURT: What is this 22 pounds?

A. I am going to make a total of 22 pounds of oil to finish with. First we shall add the Jones and kerosene proportion, which is 82 per cent of the 22 pounds and then afterwards, when we have agitated it first, we shall add the balance of that 22 pounds in the form of a pine oil.

Q. 445. MR. WILLIAMS: And then when you have added the pine oil what will you have, what mixture?

A. A mixture of 70 per cent Jones' oil, 12 per cent of kerosene and about 18 per cent of pine oil.

Q. 446. And that mixture will be used in the proportion of how many pounds to the ton?

A. Twenty-two pounds to the ton.

Q. 447. And is that defendant's mixture as testified to here?

A. If there is any difference it is possibly in the Jones' oil. Jones' oil has got so many names that I don't really know which one they used when they say

Arthur Howard Higgins.

Jones so that
"fuel oil," so that I have taken one from you ~~on what~~ I know exactly what it is.

Q. 448. Did you examine the specimens of kerosene oil that you obtained from the defendant?

A. Yes, I did.

Q. 449. What did you find in them?

A. I found in the sample of kerosene that was used by Mr. Phillips some soluble frothing agent.

Q. 450. And what did you find in the large specimen from the plant that you received?

A. I examined that also and a soluble frothing agent was in it. As I remember, Mr. Dosenbach said there was no great care exercised as to what tank they put the oil in. That is what I understood him to say.

Q. 451. And what would be your explanation of the presence of a soluble frothing agent in the kerosene?

A. The presence of some pine oil, as it got into the kerosene. It was probably left in the tank, perhaps only a little in the bottom of the tank when the kerosene had been emptied into it.

Q. 452. Mr. Higgins, when Mr. Phillips carried on his experiments, he operated the bar mixer so that it was revolving when it entered the pulp, and was also revolving when it left the pulp. Have you repeated that part of his operation?

A. Yes, I have. I find that the difference in the operation does not make a great deal of difference in the results, although there is some advantage in drawing it out, except for the splashing. The froth is

Arthur Howard Higgins.

ikely to be somewhat coarser on the surface when you draw the revolving mixer through the liquid.

Q. 453. Now, in your experiments, have you done anything of that kind? What do you do?

A. I prefer to leave the agitator in position and stop t by breaking the current.

Q. 454. And in your experiments do you start the agitator in motion when it is in position and keep it there during the operation and stop it while it is there?

A. Yes, I do.

Q. 455. And do you or do you not regard that as the best representation of the proper operation?

A. In my opinion that is the best way to do it.

Q. 456. MR. SCOTT: That is settling just as quick without the oil as the other did with the oil. Isn't it?

A. Yes; there is not much difference in the rate of settling, but I think I have stated that that is due to this alkali.

Q. 457. The mysterious alkali?

A. It is not mysterious, in my opinion.

Mr. Williams (Experiment performed.)

Q. 458. About how many pounds of oil to the ton of ore were present in the operation which you are now conducting?

A. It is about 18 pounds of a mixture of Jones and kerosene oil.

Q. 459. And when you repeat the operation and add pine oil, about how many pounds per ton will you add of pine oil?

A. About four pounds to the ton, making a total of twenty-two pounds.

Q. 460. Now, what is the result of the four-minute agitation?

A. There are a few bubbles on the surface of the pulp carrying mineral, but there is no thickness of froth there. The general result seems to be a film of mineral floating on the surface, carrying a few bubbles.

Q. 461. As a metallurgical result has that any value?

A. None whatever.

THE COURT: Is this a repetition of one of those experiments performed by the defendant?

MR. WILLIAMS: Yes sir, it is a repetition of defendant's operation without the actual frothing oil. Now, we have transmitted light through it and your honor can see that the film is very thin, practically of no value.

Q. 462. MR. WILLIAMS: Now, what are you going to do?

A. I am going to add to that .13 c.c. of pine oil which will be about four pounds to the ton, and re-agitate for another two minutes.

(Experiment performed.)

Q. 463. What is the result of the addition of four pounds of pine oil and the reagitation?

A. That has brought up to the surface of the pulp, a heavily mineralized froth, which appears to be rather denser than in the case of the kerosene and pine oil alone, the previous experiment.

Arthur Howard Higgins.

Q. 464. That is to say, comparing this experiment ith the kerosene with fuel oil and pine oil with the her experiment with kerosene and pine oil alone you ıd this froth—

A. More compact.

Q. 465. And how about the recovery as indicated the appearance?

A. I think it is a little less, but there is not any aterial difference.

Q. 466. Is it or is it not a good recovery.

A. It seems to be a very good result as far as the covery is concerned.

Q. 467. MR. SCOTT: Will you describe the under rt of the froth, its appearance as to stability and so , its general characteristics throughout?

A. The froth is, as I said before, more compact as mpared with the last experiment. It does not show y free oil, although one can detect the smell of the l in the concentrate. It does not grease the hand in uching it. The undersurface of the froth shows an pearance which we usually ascribe to the presence too much oil of some kind or another.

Q. 468. Is this the condition that would prevail in e first cell of the machine where over 1 per cent of l was being used, the same quantity that is used here, pounds?

A. What kind of machine?

Q. 469. The Janney machine, in your experience?

A. Well, I think there would be a little difference, pending a great deal on the operations and the dif-

ferent conditions you have got there. I think if you will allow the machine to overflow before the mixture has got so thoroughly agitated as it seems to have been here, that you would have a little more free oil, and that might show on touching it with the hand—you might find some free oil there.

Q. 470. Is this what you call an agitation froth, or air froth, whatever expression you use?

A. In my opinion that is an air froth.

Q. 471. How much oil was used—22 pounds to the ton?

A. Twenty-two pounds to the ton.

Q. 472. If that was made entirely with pine oil, 22 pounds per ton, would it still be an air froth?

A. I think I could tell you better if I saw it.

Q. 473. You saw a test of it the other day, the result of the operation that was carried out, the experiment?

A. Well, one has always to consider the operation and the result together.

Q. 474. Did you ever try 22 pounds of pine oil or over 1 per cent?

A. No, I have not.

Q. 475. Did you ever try over 1 per cent of any oil other than this that you have before us?

A. Oh, yes.

Q. 476. What other one?

A. Particularly oleic acid and cottonseed oil.

Q. 477. Yes, I remember the cottonseed. Was that an air froth, an agitation froth?

A. When we got up to 3.6% of cottonseed oil on

Arthur Howard Higgins.

the Butte & Superior ore, we did not get any froth at all.

Q. 478. How about the Elm Orlu ore?

A. I haven't tried it at all.

Q. 479. Didn't you try that?

A. Oh, you mean that test at the Butte Reduction Works. There there was some froth, yes.

Q. 480. You testified about that in the Hyde case?

A. Yes.

Q. 480½. You got what you called the typical froth, didn't you, with cottonseed?

A. I don't think I described it that way. As far as my memory serves me, I said at a distance of several feet I could not distinguish the difference.

Q. 481. BY MR. WILLIAMS: Mr. Higgins, did you attempt to repeat the experiment made in court by Mr. Phillips, wherein he used kerosene in the proportion of 25% of oil to the ore?

A. Yes, I did. I took the material which was supplied to us as samples of the materials used, and went to the laboratory with the machine which we borrowed from them.

Q. 482. The same machine that he used?

A. The same machine that he used, and made a test. With their materials I got the same results that Mr. Phillips got. On attempting to repeat that with the ore that we had been supplied with—

Q. 483. When?

A. During that day, that of Mr. Phillip's test.

Q. 484. And in response to a request for what—a further quantity?

A. This was the first quantity of ore we received. Mr. Dosenbach handed me the balance of the sample which was used in those tests, and there was sufficient there for two or three experiments. On attempting to repeat that operation with the kerosene we had in the laboratory, I found that we could not obtain any froth worth speaking of. There was no floating stuff on the surface of the water more than 3/16 of an inch; so that I requested a further sample of the same kind of ore, and made a great number of experiments to find out in what way I differed from the test in getting this result. I had sent from San Francisco a sample of kerosene from the Union Oil Company, sealed up so that it was exactly in the condition that kerosene is produced at the refining company's plants. I bought six different kinds of kerosene in Butte from different stores. There was no special purity requested; it was just the ordinary kerosene of commerce. I found that none of those contained any soluble frothing agent, but that the kerosene used by Mr. Phillips in his experiment contained a small amount of soluble frothing agent that was sufficient to produce the result obtained. I took a small quantity of the oil—we then had only a few c. c. left—and separated the soluble frothing agent by shaking it up with distilled water and filtering off the kerosene until the solution was perfectly brilliant; that is, it did not contain any kerosene globules. The solution was then concentrated for me by Dr.

Arthur Howard Higgins.

McIlhaney; although we were not able to isolate the soluble frothing agent present, we found that the concentrated material smelled varnish, which was probably due to some pine oil.

Q. 485. Now, in repeating this experiment with these other kerosenes than that which Mr. Phillips used, what results did you obtain?

A. Well, in every case there was a certain amount of floating material, perhaps 3/16 of an inch thick, which was chiefly oil-carrying mineral, something like the Kirby float.

Q. 486. Of any value metallurgically?

A. Very little value. The bulk of the oil and mineral sinks to the bottom of the vessel and looks somewhat like very soft granules.

Q. 487. Now, will you describe the experiment that you are about to do?

A. I shall take 250 c. c. of water at the normal temperature, between 15^{c} and 16^{c}; 60 grams of Butte & Superior ore which was handed to us by Mr. Dosenbach on the 25th of April; .16 c. c. of sulphuric acid, which is 8 pounds to the ton of ore; .15 c.c. of copper sulphate solution as obtained from the Butte and Superior plant. Then I shall mix that for half a minute, as Mr. Phillips did, and to that I shall add 18.6 c.c. of kerosene, which is 25% to the ore, and then agitate 4 minutes. I find that the temperature of the water is just below 15; it is about 14¾.

(Experiment performed.)

Arthur Howard Higgins.

Q. 488. What is the result of that four minutes' agitation?

A. Some kind of a float about 3/16 of an inch thick on the surface of the pulp. The bulk of the oil and mineral and gangue is on the bottom of the vessel.

Q. 489. And this is a repetition of Mr. Phillips' 25% kerosene oil operation?

A. Yes, with ordinary commercial kerosene. Free oil is showing on the surface of the floating material.

Q. 490. What sort of an operation is that metallurgically?

A. As it stands, useless. Now, I would like to show the addition to that of .07 of a c.c. of pine oil, being 2 pounds to the ton of ore, and we will re-agitate it for a couple of minutes.

(Experiment performed.)

Q. 491. Now, what has been the result of the addition of the pine oil?

A. Now, practically the whole of the mineral and oil has risen to the surface of the pulp. There is clean gangue at the bottom. There is some very distinct oil-mineral globules or whatever they are mixed up with it.

Q. 492. How does what you have now obtained compare with what Mr. Phillips obtained?

A. I think it is about the same. Perhaps there is a little deeper layer of floating material.

Q. 493. MR. SCOTT: Would this result have been the same if you had used the pine oil only, and not used the other oil with it, the kerosene?

Arthur Howard Higgins.

A. As regards the nature of the froth, no—that floating material, whatever it is called. I don't know whether it is froth. It seems to me to be a magma.

Q. 494. You don't call that a froth?

A. No, I call that a magma. It is simply paste.

Q. 495. Is there no air in this at all?

A. Yes, oh, yes, there is air in it.

Q. 496. Is it a question of the relative amount of air that determines in your mind the difference between a magma and a froth?

A. Not entirely. I think one has to consider the amount of oil.

WHEREUPON an adjournment was taken until 2:00 p. m.

2 o'clock p. m., May 12, 1917.

MR. WILLIAMS: I would like to withdraw Mr. Higgins until after the completion of the cross-examination of Dr. Grosvenor, as to the moving pictures, and Mr. Scott is not quite ready to proceed with that examination now, and therefore I would like to put on another witness.

JAMES WILDING, a witness called on behalf of the plaintiff, after being duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. KENYON:

Q. 1. What is your name, age, residence and occupation?

A. James Wilding, age 47; residence 101 Edith street, Oakland; occupation, metallurgist.

Q. 2. What has been your experience and training as a metallurgist?

A. My training commenced with an apprenticeship of three years to a well-known consulting chemist in Liverpool, England.

Q. 3. Give the name.

A. Edward Davis. After that I studied two years in Freibourg, Saxony, as a special student in metallurgy. I went to Mexico in 1894, and was in the service of several companies for a number of years in that country, and also in independent business.

Q. 4. Give the names of those companies.

A. The first company was Cia de Minas Michoachan.

Q. 5. And in connection with the name of each company, state what the nature of your duties with that company was?

A. I was at first assayer and chemist, and then assistant superintendent of the smelting plant of the

P. 4623, L. 26, insert " : for the third I was superintendent " after " superintendent "

James Wilding.

Cia de Minas Michoachan. Next I was for some seven and a half years with three different Guggenheim companies in Mexico; first, the Guggenheim Smelting Company; second, the American Smelting & Refining Company; third, the Guggenheim Exploration Company.

Q. 6. And what was the nature of your duties with those companies?

A. I served as assayer and chemist for the smelting plant, and ore purchasing agent, and in mine examining and valuation work.

Q. 7. Now, continue with your further experience after that.

A. I was in the service of the Cia Metallurgica de Torreon for some two and a half years as assistant smelter superintendent and representative of the company in Europe. I have also been for short periods in the service of other companies, among others the Mexican Gold & Silver Recovery Company, the Cia Minera de la Trinidad and Cia Minera de Promentorio.

Q. 8. And what was the nature of the work you did for those companies?

A. For the first of those I was chemist; for the second I was superintendent of a hypo leaching mill. In 1912 I was superintendent of a smelting plant for the Cia Minera de Terrazas.

Q. 9. What were your duties there?

A. I was metallurgical superintendent, and in fact complete superintenednt of the smelting plant.

Q. 10. And after that?

A. I left Mexico in February, 1913, and a few months after that I entered the service of Minerals Separation Company, in which I am still.

Q. 11. What have your duties been in the service of Minerals Separation Limited?

A. Investigation of the treatment of ores, and also in the field, starting up plants for experimental purposes, and supervising operations.

Q. 12. Where the flotation process of Minerals Separation was being installed?

A. Yes.

Q. 13. And where has your work in the laboratory been done?

A. In San Francisco.

Q. 14. In what laboratory there?

A. The laboratory of Minerals Separation Company.

Q. 15. What sort of work is done in that laboratory?

A. Mainly flotation testing work.

Q. 16. With how large a staff?

A. Well, that varies according to the number of men that are out in the field or in town.

Q. 17. Varies from what to what?

A. Oh, from two to four or five.

Q. 18. Mr. Wicks of the Chino Copper Company, comparing efficiencies of operation at the Hurley plant of this company, November 18th, 19th and 20th, 1916, in treating vanner concentrates (when he says

James Wilding.

that 23.7 pounds of ore per ton of feed was used) with that of the third quarter of 1916 (when he says that 8.7 pounds was used), as both these periods are shown by the figures given by him on defendant's exhibit 29—said in answer to questions 25 and 26 that the latter period (that is with 8.7 pounds of oil) shows somewhat poorer results. Please compare his figures as given on that exhibit for those three days when 23.7 pounds of oil were used with his figures as they are given for the month of October, 1916, when 10.26 pounds of oil was used, being the nearest complete month, and also with his figures there given for the third quarter of 1916, being the nearest complete quarter, and state what the fact is as to whether or not the smaller oil quantities showed on the whole the poorer metallurgical operation?

A. No.

Q. 19. In other words, interpret for us the figures Mr. Wicks himself gives on this exhibit in that regard and compare them as to value of results by taking some common standard in such way as to eliminate the fluctuation of market price from time to time?

A. As a comparison, starting with a different amount of copper in the heading, the only method of comparison that occurs to me is to take the cost of operation, considering in that cost of operation the cost of smelting the concentrate produced and the losses in the tailings. In the third quarter of 1916—

Q. 20. You have prepared a table to show what you are about to explain, have you?

James Wilding.

A. Yes.

MR. KENYON: The plaintiff's counsel offers the table prepared by the witness in evidence and it is marked exhibit 255.

Table admitted in evidence and marked PLAINTIFF'S EXHIBIT 255.

Q. 21. Will you please explain the comparison you have made, its method and the results?

A. I have taken from exhibit 29 of the defendants, the tonnage given for these three periods of heading to flotation, the copper assays of the same, the tonnage of flotation concentrate, and copper assays of the same. I then calculated the contents of the heading in copper in pounds.

Q. 22. That appears in the third column, does it?

A. It appears in the third column.

Q. 23. And is a mere computation obtained how?

A. By multiplying the tonnage by its assay.

Q. 24. In each case?

A. In each case.

Q. 25. And you say the tonnage and assay are taken from exhibit 29?

A. Yes.

Q. 26. Proceed?

A. Next I have recorded in the fourth column the ratio of concentration by dividing the tons of heading by the tons of concentrate.

Q. 27. That is a mere computation, is it?

A. Yes.

Q. 28. From the figures given on exhibit 29?

James Wilding.

A. It is from that statement direct. The contents of the concentrate have been calculated in the same way as the contents of the heading.

Q. 29. That is the third column here flotation concentrate, contents pounds of copper?

A. Yes.

Q. 30. And you got that figure in pounds by multiplying what together?

A. Multiplying tonnage of flotation concentrate by the assay of the same.

Q. 31. Now, proceed.

A. I have figured the recovery of copper by the ratio of the contents of the concentrate to the contents of the headings; that is to say, I have divided the contents of the concentrate by the contents of the headings and expressed it in percentages.

Q. 32. That is the content of the concentrate in copper?

A. Yes.

Q. 33. And the content of the headings in copper?

A. Yes.

Q. 34. That being the copper that has been actually obtained by the flotation operations out of the copper originally in the feed?

A. Yes.

Q. 35. And that figure appears in the first column of the two under the head recovery percentage copper?

A. Yes.

Q. 36. Namely, calculated by contents?

A. Yes.

James Wilding.

Q. 37. Proceed?

A. The second figure—

Q. 38. Before you proceed, is that a proper way to figure recovery?

A. Yes.

Q. 39. The most proper way?

A. Yes.

Q. 40. That is the copper that went into the flotation operation and the copper that actually came out of it.

A. Yes.

Q. 41. And went to the smelter?

A. Yes.

Q. 42. It gives you the real recovery, does it?

A. Yes, the real recovery.

Q. 43. Proceed.

A. In the next column under recovery per cent ~~column~~ copper I have given the recovery of their exhibit 29.

Q. 44. To the extent that there is any discrepancy between the two which represents the real recovery—as you have calculated it, or as exhibit 29 gives it?

A. There is considerable discrepancy.

Q. 45. And which represents the real recovery?

A. The real recovery over any continuous period of operations can only be calculated by the ratio of the copper actually in the concentrate produced to that of the copper in the heading to the mill.

Q. 46. And that actual ratio is found in the per-

James Wilding.

tenage—that actual ratio to the feed is the percentage in the first of these two columns?

A. Yes.

Q. 47. 98.13 for the third quarter of 1916?

A. Yes.

Q. 48. 98.65 for October, 1916?

A. Yes.

Q. 49. 96.84 for the three days in November, 1916?

A. Yes.

Q. 50. Proceed?

A. The tonnage of tailings was simply taken by the difference between the tonnage of headings and the tonnage of concentrate.

Q. 51. By simple subtraction?

A. By simple subtraction. In the same way the contents of the tailings expressed in pounds of copper are taken by subtraction.

Q. 52. Subtracting the total copper in the concentrate from the total copper in the feed?

A. Yes.

Q. 53. Proceed.

A. The assay of the tailings has then been calculated by dividing the contents of the tailing by the tonnage of the tailing.

Q. 54. That figure is found in the first column under the heading assay per cent copper and the column that is headed calculated by contents, is it?

A. Yes.

Q. 55. And is .175 for the third quarter of 1916?

A. Yes.

James Wilding.

Q. 56. .149 for October, 1916?

A. Yes.

Q. 57. And .489 for these three days in November, 1916?

A. Yes.

Q. 58. What is the next column?

A. The next column is their given assay.

Q. 59. Given in exhibit 29?

A. Given in exhibit 29.

Q. 60. Where that differs if at all, from the calculated assay, which is the one likely to represent the actual fact?

A. Over any continued period of operation the first column will represent more accurately the actual facts.

Q. 61. Proceed.

A. The next two columns "Loss of Copper in Tailings per Ton of Heading," that is to say, I divided the tons of tailing—the pounds of copper by the tons of heading to flotation.

Q. 62. And that figure indicates that for every ton of ore going into the feed at the head of the flotation mill, 2.62 lbs. of copper ran to waste at the foot of the mill?

A. Yes.

Q. 63. And that figure was 2.62 for the first quarter of 1916, 2.10 for October, 1916, and 6.47 for the three days of November?

A. Yes.

Q. 64. Proceed.

A. In the next column I have given the value of

James Wilding.

the copper in the tailings, reckoned per ton of heading, as if every pound of copper recovered in the form of a concentrate would be worth twenty cents net to the mill, which it would be if the market price were thirty cents.

Q. 65. That is figured by simply multiplying the pounds lost, as indicated by the first column, by twenty cents?

A. Yes.

Q. 66. Proceed.

A. "The cost of smelting concentrates." In the case of Mr. Englemann's evidence concerning the Ray mill, he said that the cost of treating ~~their~~ the Chino concentrates was $5.00 per ton.

Q. 67. A flat rate?

A. A flat rate. In their case the mill is very close to the smelting plant. I have taken that figure of $5.00 as being the likely cost of smelting their concentrates in El Paso, added $1.00 for freight from the Chino mill to El Paso.

Q. 68. That is from the Chino mill to the El Paso smelter?

A. Yes.

Q. 69. That is a fair freight rate, is it?

A. I think so.

Q. 70. And $5.00 was a fair smelting charge?

A. Yes.

Q. 71. You assume that same figure in all three cases?

A. Yes.

Q. 72. Proceed.

A. Then I multiplied the tons of concentrates produced by $6.00, giving the total smelting charge in that period of the concentrate produced. I divide that figure by the tons of heading to flotation, and obtained the cost of smelting the concentrate per ton of heading to flotation.

Q. 73. That appears in the third column of the columns headed "Cost of Smelting Concentrate"?

A. Yes.

Q. 74. Proceed.

A. In the total cost of concentration I have taken as the operating cost the letter "a," the cost being unknown to me, I then figured the total cost of the operation per ton of heading, and I have added to "a" the value of the copper per ton of heading lost in the tailing and the smelting cost of the concentrate per ton of heading.

Q. 75. In each case?

A. In each case.

Q. 76. For example in the first case the cost per ton of heading, including the loss in tailing and cost of smelting would be this factor "a"—

A. "a"—plus $2.047.

Q. 77. Plus .524, representing the loss of copper in the tailing, per ton of heading, plus 1.523, representing the cost of smelting per ton of heading; total the milling cost—"a" plus $2.047. That is what that means, is it?

A. Yes.

James Wilding.

Q. 78. And the same way with the other periods?

A. Yes.

Q. 79. In the case of the third item, what is the notation, "A plus 15 for extra oil, etc," What is the 15?

A. I imagine—Pardon me; I won't put it that way —I think it is certain that the~~y~~ir use~~d~~ of extra oil will result in adding about 15 cents per ton to the cost compared to that in ordinary operations.

Q. 80. 15 cents per ton of original feed of ore?

A. Yes.

Q. 81. Taking the cost of the extra oil at that figure, 15 cents, you get for that period as a total cost, the figure "a" plus 3.476 for the cost of concentration per ton of ore fed to the mill?

A. Yes.

Q. 82. Now, proceed.

A. The difference is in favor of the periods during which the smaller amount of oil was used.

Q. 83. The notations in the last two columns of the oils and other reagents were obtained from what source?

A. From exhibit No. 29.

Q. 84. Now, what is your conclusion based upon these figures and this comparison?

A. That during the period of working with small quantities of oil they actually made better profit than during the later period. It will not show in this case, because the heading to flotation for November 18th, 19th and 20th contained over 10% copper,

whereas in the other periods it was between seven and eight per cent.

Q. 85. But even with that difference in the heading the cost of concentration during those three days, as determined by Mr. Wicks' figures, as compared with the third quarter of 1916 was greater by $1.43 or thereabouts?

A. Yes.

Q. 86. For every ton of ore that went into the mill?

A. Yes.

Q. 87. And the cost of concentration during those three days, as determined by Mr. Wicks' figures, as compared with the cost during the month of October, 1916, was the difference between 3.467 and 2.187?

A. Yes.

Q. 88. That is to say, $1.29 or thereabouts, per ton of original ore fed to the head of the flotation plant?

A. Yes.

Q. 89. You have expressed the opinion, I believe, judging from those results, that the efficiency during the third quarter of 1916 and during the month of October, 1916, instead of being poorer than during those three days in November, was better?

A. Yes.

Q. 90. Notably better?

A. No, not notably better.

Q. 91. But better?

A. Better.

James Wilding.

Q. 92. Now, Mr. Englemann of the Hayden plant of the Ray Copper Company, comparing his own figures, given in Exhibit No. 150, for the year 1916, in retreating vanner concentrate products (when, as he says 3.36 lbs. of oil were used per ton of ore). With the figures that he gives for the first three months of 191~~6~~7 (when, as he says, 20.1 lbs. of oil were used) seems to say, in answer to Q. 32 to Q. 35, that the latter were the better, that is to say, with 20.1 pounds of oil. ~~One~~ and he figures out theoretically 17 pounds more of copper produced in 1917 per ton of ore than in 1916. This, however, he seems to take back in the answer to Q. 84, saying that that figur~~e~~ing does not really mean anything, if I understand him correctly, and he substitutes some other method of comparison by tonnage and assay of feed, concentrate and tailings, from which he figures the amount of copper running to waste in the tailings per ton of ore fed, and so compared, he finds the two periods practically the same, and he leaves it there. Now, if you are able to do so from the figures given by Mr. Englemann on exhibit 150, please compare the first quarter of 1917 with an equal period in 1916, and with a period in 1916 when the other mill conditions were presumably nearest to those of 1917—namely, the last quarter of 1916; and state how the results compare metallurgically, not only in respect to the relative amount of copper going to waste in the tailings, but also with respect to all other matters (omitted by Mr. Engel-

James Wilding.

mann,) that would be considered and would have to be considered in practice. Have you prepared a table that will show these conclusions?

A. I have prepared a table comparing the results of the fourth quarter of 1916 with those of the first quarter of 1917.

Table offered in evidence by plaintiff admitted marked PLAINTIFF'S EXHIBIT No. 256.

Q. 93. Will you now please explain this table as you did the other?

A. From Exhibit 150 I have taken the weight of headings to flotation and its assay, and the weight of flotation concentrates produced and its assay and calculated in each case the copper contents as before.

Q. 94. For example, the copper contents of the heading to flotation in the last quarter of 1916 was 3,327,005 pounds?

A. Yes.

Q. 95. And the copper contents of the flotation concentrate for that same quarter was 3,210,974 pounds?

A. Yes.

Q. 96. Now, proceed.

A. I have then calculated the copper recovery in the concentrate expressed as to per cent by dividing the copper contents of the concentrate by the copper content of the heading.

Q. 97. That gives you for the last quarter of 1916

James Wilding.

a calculated recovery of 96.51 per cent of the copper?

A. Yes.

Q. 98. And for the first quarter of 1917 a calculated recovery of 95.12 per cent of the copper?

A. Yes.

Q. 99. You passed the column headed "rate of concentration." What about that?

A. The ratio ~~rate~~ of concentration it should be.

Q. 100. It should be ratio, should it?

A. The weight of heading to flotation divided by the weight ~~contents~~ of concentrates produced.

Q. 101. Should that word be "ratio"?

A. Ratio.

Q. 102. Now, proceed. The second column under the heading "recovery"?

A. Is the figure given in exhibit 150.

Q. 103. And, before I proceed on this question, the figure given in the column "calculated" is the actual copper realized as a result of the whole operation, realized in the concentrate out of the copper in the feed?

A. Yes.

Q. 104. Now, proceed with the tailing?

A. The tailings, first column is the total of tailings.

Q. 105. How obtained?

A. By subtraction of the tonnage of concentrates from tonnage of headings. The contents of the tailing in pounds of copper is also taken by the difference

between the contents of the heading and the contents of the concentrate.

Q. 106. And represents the actual copper of the headings that was not found in the concentrates?

A. Yes.

Q. 107. Proceed.

A. The copper assay is then calculated by dividing the contents in copper by the tonnage of the tailing.

Q. 108. That figure "calculated assay of copper" is the actual copper in pounds not accounted for in the concentrate, divided by the tonnage of the tailings?

A. Yes.

Q. 109. And the next column?

A. And the next column is the assay given in exhibit 150.

Q. 110. Proceed.

A. The loss of copper in tailings per ton of heading. That is calculated by dividing the contents of the tailing by the tonnage of the heading.

Q. 111. That is to say dividing the contents in pounds of copper of the tailing, 116,031 pounds in the first period, by the tonnage of the headings?

A. Yes.

Q. 112. That figure shows for the last quarter of 1916 a loss of 4.25 pounds of copper in the tailings for every ton of ore fed to the flotation plant?

A. Yes.

James Wilding.

Q. 113. And during the first quarter of 1917 a loss of 6.37 pounds of copper for every ton of ore fed to the flotation plant?

A. Yes.

Q. 114. Proceed.

A. The value of that copper lost in the tailings per ton of headings is then calculated at a price of twenty cents.

Q. 115. Net at the mill?

A. Yes.

Q. 116. Giving for the first period eighty-five cents per ton of headings and for the second period 1.27 per ton of headings?

A. Yes.

Q. 117. Proceed?

A. Cost of smelting concentrate. The smelting charge of $5.00 per ton of concentrate was given by Mr. Englemann.

Q. 118. You make no allowance here for freight?

A. No.

Q. 119. Why is that?

A. Well, they are near to the smelting plant.

Q. Proceed.

A. The total is arrived at by multiplying the tonnage of the concentrate by five dollars, and working back to tons of heading, dividing by the tons of the same, so that the cost of smelting the concentrates for the first of the two periods in question was during the last quarter of 1916 $1.12 per ton of heading.

James Wilding.

A. $1.37.

Q. 122. Proceed.

A. Then I have taken as a milling cost, "a" and added the value of the copper lost in the tailing.

Q. 123. In the first case, eighty-five cents per ton of heading?

A. And then the cost per ton of the headings ~~to~~ or smelting the concentrates produced.

Q. 124. In the first case $1.12 per ton of headings?

A. Yes.

Q. 125. And what about the entry fifteen cents for extra oil in the second period?

A. I think that is what it would cost them extra, pursuing that method of operation.

Q. 126. This method of calculation, gives as the cost of concentration during the last quarter of 1916 the milling cost, whatever that is, plus $1.97 per ton of heading, and for the first quarter of 1917 that same milling cost plus $2.79 per ton of heading. That is correct, isn't it?

A. Yes.

Q. 127. So that the difference in cost of concentration is eighty-two cents?

A. Yes.

Q. 128. Per ton of ore fed to the flotation plant?

A. Yes.

Q. 129. And was that much greater during the first three months of 1917 than during the last three of 1916?

James Wilding.

A. That was greater.

Q. 130. Where did you get the items under the heading "oil pounds per ton of heading"?

A. From exhibit 150.

Q. 131. What is your conclusion then, from this comparison?

A. That the period of the fourth quarter of 1916 was more successful, metallurgically, than the period of the first quarter of 1917.

Q. 132. There is a legend, a note at the bottom of this exhibit 256. Will you please explain that?

A. On account of the lower grade of concentrate produced, it must contain, if it is produced from similar feed, a greater amount of gangue and that would make in smelting a larger amount of slag, which would carry additional copper off.

Q. 133. So that in addition to the greater loss of copper in the concentrating operation itself, there would be a greater loss of copper in the smelting operation?

A. Yes.

Q. 134. And the difference in grade of concentrate to which you refer is shown on this table under the heading "flotation concentrate, assay copper" and is in the last quarter of 1916 26.38, and in the first quarter of 1917 22.76, is it?

A. Yes.

Q. 135. These figures being taken from exhibit 150?

A. Yes.

MR. KENYON: Plaintiff's counsel offers in evi-

dence the sworn statement of the Butte & Superior Copper Company, Limited, for the month of January, 1916, filed pursuant to order of court, entered in the above entitled action on November 15th, 1913, and now of record in this case, in this court, and similarly the similar and successive monthly statements from that report down to and including the report of March, 1917.

MR. KREMER: May I inquire the purpose? Perhaps I want to object.

MR. KENYON: To give the basis of the figures the witness is about to present comparing the procedure of the defendant in the year 1916 with its procedure in the year 1917, as to the results, how they correspond.

MR. KREMER: Has it to do with the operation itself or is it introduced purely for the purpose of making a financial comparison?

MR. KENYON: Just a comparison.

MR. KREMER: Financial or otherwise?

MR. KENYON: No, not financial, metallurgical, the same sort of metallurgical comparison we have been making in the other two plants.

MR. KREMER: We have no objection.

Statements admitted in evidence and marked PLAINTIFF'S EXHIBITS 257 to 271 inclusive.

Q. 136. MR. KENYON: Please compare metallurgically the oil flotation achieved by the Butte &

James Wilding.

Superior Mining Company, defendant, during the last quarter of 1916 as shown in certain monthly statements on file, being exhibits 266, 267 and 268, when considerably under three pounds of oil per ton of feed was used, as shown in exhibit 158, with the first quarter of 1917 as shown in such monthly reports, being exhibits 269, 270 and 271, when about twenty pounds of oil was used, as appears on exhibits 159. 161 and 162, and if you have prepared a statement for that purpose, will you please produce it?

A. I have here a statement comparing the results of the last quarter of 1916 with those of the first quarter of 1917.

MR. KENYON: The plaintiff offers the tabulation produced by the witness in evidence.

Tabulation admitted in evidence and marked

PLAINTIFF'S EXHIBIT 272.

Q. 137. Will you please now explain this exhibit 272?

A. The monthly statements from which the figures are taken, give the tons of ore delivered to the flotation plant.

Q. 138. This appears in the first column, does it?

A. Yes. The assay of the same.

Q. 139. That appears in the second column?

A. Yes.

Q. 140. Assay in zinc?

A. Yes. The tons of concentrate produced.

Q. 141. That appears in the first column under the heading "concentrates" does it?

A. Yes. The assay of the same.

Q. 142. The assay per cent of zinc?

A. Yes.

Q. 143. That appears in the second column under the heading "concentrates," does it?

A. Yes.

Q. 144. Please proceed.

A. The cost of flotation per ton of concentrate produced.

Q. 145. Where is that found?

A. That is found in the last column of the tabulation.

Q. 146. Proceed with your description of the table?

A. I have calculated from these figures the contents of zinc in the heading.

Q. 147. And this content in tons is found in the third column under the heading "ore delivered to plant"?

A. Yes. The zinc contents tons of the concentrates.

Q. 148. These appear in the third column under the heading, "Concentrate," and are in tons, are they?

A. Yes, they are. The recovery of zinc in the concentrate.

Q. 149. How about that figure?

A. By dividing the contents of the concentrate by the contents of the heading.

Q. 150. That is to say that figure for October, 1916, being 93.582 means that the total tons of zinc

James Wilding.

contained—total tons of zinc content of the concentrate for that month, namely 7,579.98 tons was that percentage of the total zinc content of the ore delivered to the plant during that month, namely 8,099.83 tons?

A. Yes.

Q. 151. And so with each lower figure in this "recovery" column?

A. Yes.

Q. 152. Is that a proper way to figure recovery?

A. Yes.

Q. 153. Is that the best way to figure recovery?

A. Over any continued period of operation.

Q. 154. Being the copper actually recovered by the whole process compared with the copper that went into the operation at the head of the mill?

A. Yes.

Q. 155. Before we leave the matter of recovery. The last quarter of 1916 shows according to your figures a recovery of 92.941 per cent, and the first quarter of 1917 shows a recovery of 83.110 per cent, does it?

A. Yes.

Q. 156. And before we leave it, the grade of the concentrate, the average grade of the concentrate produced during the last quarter of 1916 was 53,254 per cent in zinc?

A. Yes.

Q. 157. And for the first quarter of 1917 was 47.228 per cent in zinc?

A. Yes.

Q. 158. Now, proceed.

A. The tons of tailings going to waste are taken by subtracting the tons of concentrate produced from the tons of heading. The contents of the tailings in zinc is also taken by the difference between the contents of the concentrate and the contents of the heading.

Q. 159. You subtract the total zinc content in the concentrate from the total zinc content in the ~~tons of~~ heading?

A. Yes.

Q. 160. And that tonnage of zinc must have gone to waste?

A. Yes. I then calculated the pounds of zinc going to waste in the tailings per ton of heading delivered to the plant.

Q. 161. Calculated that in what way?

A. By dividing the pounds of zinc in the tailing by the tons of ore in the heading.

Q. 162. That computation shows that in the last quarter of 1916 for every ton of ore fed to the flotation plant 19.11 pounds of zinc ran to waste in the tailing and that for the first quarter of 1917 for every ton of ore fed to the head of the flotation plant 43.22 pounds of zinc ran to waste in the tailings, does it?

A. Yes. I have then calculated the amount of zinc in the tailings by dividing the zinc contents by the tons of the tailings.

James Wilding.

Q. 163. That shows for the last quarter of 1916 that the tailings assayed 1.24 per cent of zinc, and for the first quarter of 1917 that the tailings assayed 2.789 per cent of zinc, does it?

A. Yes. I have given the zinc assay which is given in these sworn statements in the other column for the sake of comparison.

Q. 164. Now, as to the last three columns under the heading "costs"?

A. The sworn statementS give~~s~~ costs of the operation per ton of concentrate produced. This multiplied by the tons of concentrate gives the total cost. That divided by tons of heading gives the cost per ton of heading.

Q. 165. So that in the last column you have the figure which is given in these sworn monthly statements of the cost per ton of concentrate?

A. Per ton of concentrate produced.

Q. 16~~5~~6. Multiplying that figure by the number of tons of concentrate produced in that interval, which is also given in the statement, is it?

A. Yes.

Q. 167. And you get the total which appears in the first of the last three columns?

A. Yes.

Q. 168. Then you divide that total by the total tonnage that was delivered to the plant during that interval as also appears in the monthly statements?

A. Yes.

Q. 169. And you then get the final figure in the middle of these last three columns, the cost per ton of ore delivered to the plant?

A. Yes.

Q. 170. That calculation shows that during the last quarter of 1916 that cost was a little over eighty-two cents per ton of ore delivered to the plant?

A. Yes.

Q. 171. And for the first quarter of 1917 that cost was $1.34 per ton of ore delivered to the plant?

A. Yes.

Q. 172. What is your conclusion as to the comparative efficiency or merit of the operation during these two periods?

A. That the operations for the first quarter of 1917 were very much less successful than those for the last quarter of 1916.

Q. 173. I notice some difference in the grade of the ore delivered to the plant from month to month. Does that introduce some differences, or may it introduce some differences?

A. Yes.

Q. 174. Now, in order to eliminate that as much as possible, I will ask you to compare the month of March, 1917 with the month of January, 1916, as both are shown in these monthly reports, March, 1917, being Exhibit 271 and January, 1916, being Exhibit 257, and I have selected those two months because they are most nearly alike in the grade of the headings, in the grade of the feed; also similarly, February 1917 with June, 1916, being exhibit 270 with exhibit

James Wilding.

262, those two months being very similar in the grade of the feed and the third, January, 1917, with November, 1916, being exhibit 269 with exhibit 267, and also for the same reason, the grade being very similar in those months. If you have prepared a table?

A. I have.

Q. 175. Please produce it.

A. (Table produced.)

MR. KENYON: Plaintiff's counsel offers the paper produced by the witness in evidence.

Said table admitted in evidence marked

PLAINTIFF'S EXHIBIT No. 273.

Q. 176. Will you please now explain this table and the different legends on it?

A. I have taken from the statements of the manager of the Butte & Superior Company, monthly statements,—the tons and assays of the ore delivered to flotation plant, and the tons and assay of concentrates produced, the cost per ton of concentrate produced; I have then calculated the value of the concentrates produced in each of these months by assuming certain terms of sale with a market price for the spelter at $9.50 per 100 lbs. The formula adopted for the sake of this comparison, in these conditions and the sale terms, are given below in appendix No. "A" with an example of working out the value.

Q. 177. You may explain that later. That elimin-

James Wilding.

ates the differences in the price from time to time, does it?

A. That is the way it is figured.

Q. 178. And it gives a comparison of the metallurgical results obtained?

A. Translated into dollars.

Q. 179. The first two columns, tons and assay of zinc, you obtained from the monthly statements, I understand?

A. Yes.

Q. 180. The third column you figured how?

A. By multiplying the tons of heading to flotation by the assay.

Q. 181. Giving the total tons of zinc contents of the heading to flotation?

A. Yes.

Q. 182. The same way with the concentrates?

A. Yes.

Q. 183. The third column there you have figured in the same way?

A. Yes.

Q. 184. And as to the recovery, how have you figured the recovery of zinc by contents?

A. The recovery is the ratio of the contents of the concentrates to the contents of the heading, in zinc, expressed in percentage.

Q. 185. The actual zinc that was recovered, the percentage of that to the actual zinc which went in with the heading?

A. Yes.

James Wilding.

Q. 186. That figure, then, is the actual recovery, even though a calculated figure?

A. Yes.

Q. 187. And that figure in the first of the three comparisons called for shows in January, 1916, 93.117?

A. Yes.

Q. 188. As contrasted with March, 1917, 85.228?

A. Yes.

Q. 189. A difference of 7.889 in favor of January, 1916?

A. Yes.

Q. 190. And for the second comparison it shows that June 1916 was 93.972; for February, 1917, 81.155, a difference in favor of June, 1916, of 12.817%, does it?

A. Yes.

Q. 191. And as to the third comparison, for November, 1916, it shows 92.929, and for January, 1917, 82.858, a difference in favor of November, 1916, of 10.071%, does it?

A. Yes.

Q. 192. And just before you leave that, the grade of the heading in the two months first compared, January 1916, and March, 1917, are very close, are they, 12.496 in one case and 12.489 in the other; that is close, is it?

A. Very near.

Q. 193. And the second two months compared, show, June, 1916, 12.976 grade of heading and February 1917, 12,988. That is close, is it?

A. Yes.

Q. 194. And in the third comparison, November, 1916 shows 13.001 and January, 1917, 12.923 grade of heading; that is close, is it?

A. Yes.

Q. 195. That was the reason these months were selected, was it?

A. The only reason.

Q. 196. Now proceed to the tailings.

A. Under the heading "Tailings" I have calculated the weight of the tailing going to waste by the difference between the weight of concentrates produced and the weight of heading, in the same way I have calculated the contents of the tailings in zinc.

Q. 197. The third column, under the heading "Tailings" shows the pounds of zinc running to waste for every ton of ore fed to the flotation plant, does it?

A. Yes.

Q. 198. Pausing to compare them a moment, in January, 1916, 19.23 lbs. of zinc went to waste in the tailings for every ton of ore treated?

A. Yes.

Q. 199. In March 1917, 36.90 lbs. of zinc was run to waste?

A. Yes.

Q. 200. Showing a difference of 15.67 lbs. of zinc in favor of the earlier period?

A. Yes.

Q. 201. In the second comparison, in June, 1916, 15.65 lbs. ran to waste and in February, 1917, 48.95

James Wilding.

lbs. ran to waste, showing a difference of 33.30 lbs. of zinc per ton of heading in favor of the earlier period?

A. Yes.

Q. 202. And with respect to the third comparison, November, 1916, showed 18.39 lbs. of zinc running to waste, and January, 1917 showed 44.30 lbs. of zinc running to waste, with a difference of 25.91 lbs. of zinc per ton of heading in favor of the earlier period?

A. Yes.

Q. 203. Now, proceed to the next column and explain the heading "Assay ~~of~~ % Zinc" and "Calculated by Contents."

A. To arrive at the tailings assay of zinc I divided the contents of the tailings by the tonnage of the same.

Q. 204. That calculation shows, in the case of the first comparison, in January, 1916, 1.093% of zinc running to waste, the tailings containing 1.093% of zinc running to waste, and in March, 1917, the tailing containing 2.382% of zinc running to waste, with a difference of 1.289% in favor of the earlier period?

A. Yes.

Q. 205. And in the second comparison, January, 1916, shows 1.007% tailings; February 1917 shows tailings containing 3.183% zinc, with a difference in favor of the earlier period of 2.175% zinc?

A. Yes.

Q. 206. Third comparison, November, 1916, shows 1.187% zinc, January, 1917, 2.838% zinc, with a difference of 1.651% in favor of the earlier period?

A. Yes.

Q. 207. What are the figures in the column given under "Assay % Zinc"?

A. They are given in the statements.

Q. 208. Under the headings "Oils and Acids per Ton of Heading"?

A. Those are taken from exhibit No. 158.

Q. 209. And are approximate?

A. Approximate.

Q. 210. Now, explain under the heading "Cost" what figure is given in the monthly statements.

A. As to cost, the statement gives the cost per ton of concentrate produced.

Q. 211. That is the middle column?

A. That is the middle column. By multiplying the tons of concentrates produced by that figure you get the total cost.

Q. 212. In the third column?

A. Third column. By dividing the total cost by the tons of heading to flotation you get the cost per ton of heading.

Q. 213. You get the first column?

A. Yes.

Q. 214. Now, that total cost per ton of heading in the case of the first comparison, January, 1916, and March, 1917, showed a difference of over 70 cents per ton of heading in favor of the earlier period?

A. Yes.

Q. 215. And the second comparison, June, 1916,

James Wilding.

and February, 1917, showed a difference of 56 cents a ton of heading in favor of the earlier period?

A. Yes.

Q. 216. And in the case of the third comparison, November, 1916, with January, 1917, there was a difference of 56—nearly 57 cents in the total cost in favor of the earlier period?

A. Yes.

Q. 217. Now, explain the next three columns.

A. To arrive at the value per ton of zinc concentrates produced we have assumed or taken a set of sales conditions.

Q. 218. Shown in Appendix A?

A. Shown in appendix A.

Q. 219. A fixed set for all periods?

A. The same for all periods.

Q. 220. And are those fair conditions that you have there assumed?

A. I think they are fair for the whole period covered.

Q. 221. Please explain them.

A. The market price of zinc during 1916—the average market price was over 12 cents. We have assumed 9½, because 1917 comes under a period of lower spelter prices.

Q. 222. That is, your first item which says "Assumed Market Quotation for Spelter, $9.50 per hundred pounds, being below the average for the period in question," that is what you have just explained, is it?

A. Yes.

Q. 223. Now, proceed.

A. An example is then given.

Q. 224. Explain the next item, for one ton of concentrates of 45% zinc.

A. The base price is taken at $21.00 for 45% zinc.

Q. 225. That is a usual contract price is it?

A. Yes.

Q. 226. Now, explain the next item.

A. On each rise or fall of the market quotation one dollar above the base quotation, $5.00 per 100 lbs. above or below, $6.00 is added to or taken from the base price per ton of concentrates.

Q. 227. For each $1.00 rise above $5.00 there is $6.00 per ton of concentrate added to the value of the concentrate?

A. Yes.

Q. 228. What is the next item?

A. For each unit of zinc assay in the concentrate above 45% we have added 90 cents per ton to the concentrates.

Q. 229. That is an added value of the concentrate for each per cent of grade above 45%?

A. Yes.

Q. 230. And does that represent fair market conditions?

A. Yes.

Q. 231. What is the last item?

A. Allowed to cover the cost of freight to market

James Wilding.

and loading and freight on the moisture in the concentrates, $8.00.

Q. 232. Now, will you explain this example in which that formula is applied?

A. I have taken the concentrate of January 16th, 54.59% zinc. The base price for concentrate of 45% zinc is $21.00. Bonus for increase in grade would be 9.59 units at 90 cents, $8.63.

Q. 233. That feature of increase of grade would add to the value of each ton of concentrates $8.63?

A. Yes. Bonus for increase in market price, 4.5 units at $6.00, $27.00.

Q. 234. The total is $56.53?

A. Yes. From this total has been deducted $8.00, as shown in the formula.

Q. 235. Leaving $48.63?

A. As the net value at the mill of one ton of concentrates.

Q. 236. And where have you entered that figure?

A. In the middle column under the heading "Sales Value of Concentrates on Equal Terms as Shown in Appendix A."

Q. 237. Zinc only, what does that mean?

A. There is no silver being taken into account or the gold in the concentrate.

Q. 238. That would add to the value?

A. It would add to the value.

Q. 239. And so for each of the six figures in that middle column, $48.63 for January, 1916, you have

calculated it out in the same way and according to that same rule?

A. Yes.

Q. 240. That shows that as between January, 1916, and March, 1917, each ton of concentrate was worth $6.64 more in the earlier period, does it?

A. Yes.

Q. 241. And as between June, 1916 and February, 1917, each ton of concentrate was worth $8.04 more in the earlier period?

A. Yes.

Q. 242. And as between November, 1916 and January, 1917, each ton of concentrate was worth $4.23 more in the earlier period?

A. Yes.

Q. 243. Now proceed.

A. By multiplying the tons of concentrates produced by the sales value per ton, we have a total sales value of concentrates produced.

Q. 244. Which you show in the last of those three columns under the heading, "Sales Value"?

A. Yes.

Q. 245. Which shows a difference in the case of the first comparison of $65,417.00 in favor of the earlier period. In the case of the second comparison $121,526.00 in favor of the earlier period, and in the case of the third comparison $104,599.00 in favor of the earlier period, does it?

A. Yes.

Q. 246. Now, how do you get the first column?

James Wilding.

A. The first column is arrived at by dividing the total sales value by the tonnage of heading to flotation.

Q. 247. Which shows in the case of the first comparison a difference of 89 cents in favor of the first period?

A. Yes.

Q. 248. And $1.49 in the second comparison in favor of the earlier period?

A. Yes.

Q. 249. And $1.23 in favor of the first period in the third comparison?

A. Yes.

Q. 250. Now, the last two columns headed "Profit".

A. The profit is arrived at by subtracting from the sales value per ton of heading the cost per ton of heading, and in the same way per ton of concentrate produced.

Q. 251. Subtracting this cost per ton of heading from the sales value per ton of heading, you get the ultimate profit per ton of heading, do you?

A. Yes.

Q. 252. And in the case of the first comparison, that shows an advantage of $1.60 per ton of heading in favor of the earlier period over the later?

A. Yes.

Q. 253. And in the case of the second comparison a profit of $2.05 per ton of heading in the earlier period over the later?

A. Yes.

James Wilding.

Q. 254. And in the case of the third comparison a profit of $1.81 per ton of heading in favor of the earlier period over the later?

A. Yes.

Q. 255. And the last column is what?

A. The last column is the profit realized per ton of concentrate produced, arrived at in the same way.

Q. 256. Now, what is the note above Appendix A; will you explain that?

A. The figures indicate that the modification of operating with excess of oil would cause a decrease of profit from the zinc alone of about $1.75 per ton of ore delivered to the flotation plant. The tonnage figure seems to me to imply that it would be necessary to provide more equipment in the mill to get the same capacity as it had under the older mode of operation.

Q. 257. The figures indicate to you that the total tonnage capacity of the mill has been reduced?

A. Yes.

Q. 258. What else?

A. The silver loss is also somewhat greater, but I have not taken it into account; that is, the silver loss in the 1917 period. With the market price of spelter 9.50, the decreased profit on one year's heading to flotation, says: 580,000 tons, would be about $1,-015.000.

MR. KENYON: The witness is yours, Mr. Scott.

MR. SCOTT: I would like to cross examine the

witness for a moment to get at his method in some of these calculations and afterwards I would like to have an opportunity to check over all of these calculations before I complete it.

THE COURT: Yes.

CROSS EXAMINATION

BY MR. SCOTT:

X-Q. 259. Take the first, Mr. Wilding, your calculations and tabulation of the result at the Chino Copper Company on the vanner concentrate, exhibit 255, I would like to ask you first whether the ratio of concentration which you have adopted in this table does not depend on the usual formula, ratio of concentrate is equal to the assay of concentrate minus the assay of tails divided by the assay of heads minus the assay of tails?

A. This ratio of concentrate is the number of tons of heading that are necessary to produce one ton of concentrate.

X-Q. 260. My question is how you derive the figure, take 3.94 for the third quarter of 1916, my question is where you get the 3.94? You get it by the formula, do you not?

A. I get that by dividing 26,804 by 6,804.

X-Q. 261. You do that upon the presumption that 6,804, the tons of concentrate was an actual weight, did you not?

A. Yes.

X-Q. 262. You were not here when Mr. Wickes testified that 6,804 tons of concentrate was simply cal-

James Wilding.

A. No, I was not.

X-Q. 263. And if the 6,804 tons, the figure for concentrate, was derived by the formula, then your calculation is fallacious is it not?

A. My calculations are based on the figures given.

X-Q. 264. But if the figure that is given was derived upon the formula?

A. I haven't calculated it in that method at all.

X-Q. 265. I know you haven't, but I say if the figure, tonnage of concentrate, was derived by the formula, then your method of using that tonnage to find the ratio of concentrate from, is based upon an error, is it not?

A. That tonnage must have been derived from the formula, then.

X-Q. 266. It was derived from the formula?

A. Then it should work back to the heading correctly.

X-Q. 267. That is the question. It was derived from the formula?

A. Well, now, if it was derived from the formula it should work back correctly to the heading in this way.

X-Q. 268. Well, that being the case, the ratio of concentration still does depend upon the formula because you start with a concentrate tonnage that depends upon the formula? Isn't that correct?

A. You start with a concentrate figure, yes; and the tonnage given for the concentrate.

X-Q. 269. Now, assuming that that flotation ton-

James Wilding.

nage was derived by the formula, then you simply work back to a ratio of concentrate which also depends on the formula?

A. If these ore weights are not given, they are calculated, and of course that depends upon the method he took for calculating.

X-Q. 270. Well, we will assume them to be correct, that that tonnage was—the concentrate tonnage was calculated upon the formula?

A. Yes.

X-Q. 271. The record will show it, but for the purpose of answering me you may assume that it is so?

A. Yes.

X-Q. 272. Now that being the case, this figure for the ratio of concentrate, 3.94, 3.4 and 2.94 for the three periods, all of them depend upon the formula which involves the assay of concentrate, the assay of tails and the assay of heads?

A. Yes.

X-Q. 273. Now, using tonnages based on this ratio of concentration, have you not calculated a value for the assay of the tailings?

A. Yes, of course. Everything depends on the weight of the concentrate and the weight of the heads.

X-Q. 274. And this being the case, the calculated assay of tailings which you have computed and inserted in this table does not agree with the actual assay?

A. No, it does not.

X-Q. 275. And with this information, that these

—that this flotation concentrate tonnage was calculated, you would not say, would you, that your figure for the assay of the tailings which does not check the number it started with, is more accurate than the original tailings assay?

A. There is evidently a very great discrepancy that seems to be due to imperfect work. If the tonnage concentrate calculated by any formula that you are to take is not that sum, not that amount, then it either cannot be correct or else the tailings assay cannot be correct, or some other assays. There must be some imperfection—some imperfect work somewhere, else these things would check.

X-Q. 276. Where is the error?

A. I cannot say where the imperfection was in the work.

X-Q. 277. Well, now, in view of this which do you think is the more accurate, your calculated assay of tailings derived as it is from three factors, one of which is the analytic assay figure itself, or that actual assay return?

A. I cannot express any actual opinion as to that. If the work was imperfect then I shall not say where the imperfection crept in and which is the more accurate assay.

X-Q. 278. I think you should be able to give me an opinion on this subject. We have here in this table the actual assay of tailings?

A. Yes.

James Wilding.

X-Q. 279. Taken by reliable sampling means?

A. Yes.

X-Q. 280. And assayed presumably by reliable assayers?

A. Yes.

X-Q. 281. And we have also figures—now, you have taken these actual assay figures in connection with other assay figures and have compiled another tailings assay. Now, can't you give me an opinion as to whether you think that by calculating, making a calculation based upon an actual assay and thereby calculating an assay, do you think your estimated, compiled assay is more accurate than the actual assay you started with?

A. Given these figures, if the given assay—if the given tailings assay is correct and the given heading is correct, then the given concentrate assay must be wrong.

X-Q. 282. I don't believe you have answered my question. My question is whether you think your calculated assay of tailings is more accurate than the assayer's own return?

A. Well, I say that if that is correct and the other assay which I presume is just as reliable as the tailings assay—

MR. KENYON: Indicating headings assay.

THE WITNESS: (Continuing)—then your concentrate assay must be wrong. There must be some error in the work in order to arrive at different results by the two methods.

(Question read as follows: "I don't believe you have answered my question. My question is whether you think your calculated assay of tailings is more accurate than the assayer's own return?")

MR. SCOTT: You must have an idea. That is susceptible of an answer.

A. The concentrate assays then is wrong or the headings assay is wrong.

X-Q. 283. I insist upon you answering the question?

A. I cannot express an opinion as regards the work. The figures show considerable discrepancy.

X-Q. 284. You mean to say then that having this assay figure, you intend to convey to me the idea that you do not know whether these calculated assays are more or less accurate than the actual assay you started with, to base your calculation on? You do not know?

A. Over a long period of time I would say that we have far more accurate results from samples of headings and concentrates than we have of tailings. Then, as a consequence, recoveries figured on the basis given, of calculations is more accurate than one calculated by the formula of assay to headings, concentrate and tails; and on that account, the only method of arriving at the amount of valuable material going away in the tails is by difference.

X-Q. 285. Is by what?

A. By difference of contents.

James Wilding.

X-Q. 286. Well, I do not think you have answered the question yet. My question was whether you think your computed assay of the tailings, which starts out with the real assay and utilizes it with two other assays, is more accurate than the actual assay returned to start with—actual assay returned you started with?

A. Well, then, we started with an assay of the heads that is wrong or an assay of the concentrate that is wrong.

X-Q. 287. You refuse to answer the question.

A. I think in the form in which you put it I am not called upon to express an opinion as to the accuracy of their work. Both cannot be true.

X-Q. 288. You think it is more accurate or you do not think it is more accurate, or you do not know anything about it?

THE COURT: The witness takes the three assays and says they cannot all be correct and has told you it is more likely the error is in the tailings assay than anywhere else for reasons that he gives. That comes pretty near answering it. Of course he does not give you a yes or no answer. He says there is bound to be an error there somewhere, because you cannot find your copper in these assays.

MR. SCOTT: Well, take your assumption that you think the greatest possibility of error is in the tailings assay as compared to the heads and concentrates, now, even making that presumption; do you think this calculation of yours will give you a more accurate figure than the tailings assay with which you started?

A. I can't quite see that, Mr. Scott.

(Question read.)

A. It will give me an accurate figure for recovery, but not necessarily more accurate than the other. As I say I cannot express an opinion as to the accuracy of the work.

X-Q. 289. Is there any other possibility of accounting for the difference that exists in your figures besides an error in assay?

A. Imperfection of work I say, not necessarily in assay.

X-Q. 290. In what work?

A. The work of sampling or weighing the heads or something or of assays.

X-Q. 291. Might be in any of those places.

A. Yes.

MR. SCOTT: For the present I would like to discontinue this cross examination and have an opportunity to go into these figures thoroughly before resuming it.

Witness excused.

M. W. ATWATER, recalled, testified as follows:

DIRECT EXAMINATION.

Q. 1. BY MR. WILLIAMS: Mr. Atwater, have you made a full calculation which Mr. Scott (Kremer) requested you to prepare and have you the figures of that calculation with you?

Maxwell W. Atwater.

A. I have, and I have the figures with me.

Q. 2. Upon making that calculation what results did you obtain?

A. The total estimated increase in net profits would be $1,104,815.38.

MR. WILLIAMS: I think I will offer the calculation in evidence.

MR. SCOTT: I object to its admission in evidence on the ground that it is incompetent, irrelevant and immaterial, having no bearing upon any of the issues in the case.

MR. GARRISON: They asked for it, and we furnished it.

MR. WILLIAMS: The evidence is in. This is merely an explanation.

THE COURT: The evidence is in. This is merely a compilation. I do not know how much weight it is entitled to, if any, but it will be admitted, and the objection will be overruled.

Tabulation admitted in evidence and marked Plaintiff's Exhibit 274.

MR. WILLIAMS: The witness is offered for cross examination on this compilation.

MR. SCOTT: No cross examination.

Witness excused.

Eltoft Wray Wilkinson.

ELTOFT WRAY WILKINSON, called as a witness in behalf of the plaintiff in rebuttal, being first duly sworn, testified as follows:

DIRECT EXAMINATION.

Q. 1. By MR. KENYON: State your name, age, residence and occupation?

A. Eltoft Wray Wilkinson, 30 years old, metallurgist and engineer.

Q. 2. Residence?

A. San Francisco is my principal residence.

Q. 3. What has been your education and training in metallurgical directions?

A. In metallurgical directions I have had no training except the last seven years with the Minerals Separation. My previous education was not in metallurgy at all. It was engineering work.

Q. 4. What was your engineering education?

A. I took a course in electrical and mechanical engineering at the University of Leeds.

Q. 5. In England?

A. In England. I graduated with honors in electrical engineering, taking mechanical engineering, physics and mathematics besides.

Q. 6. What has your experience been in metallurgical directions?

A. For the last seven years I have been employed by Minerals Separation both in England and United States, and also in Mexico to a certain ~~amount.~~ extent Dur-

Eltoft Wray Wilkinson.

ing that time I have been engaged in testing ores and investigating their treatment and starting up and running and installing flotation plants.

Q. 7. Laboratory work and field work?

A. Laboratory work and field work, both.

Q. 8. And handling all sorts of problems in connection with such installations?

A. Yes.

Q. 9. I wish you would compare the Butte & Superior Mining Company's figures for its oil flotation on zinc ore during the first quarter of 1917, as given in its sworn monthly reports, being Exhibits 269, 270, and 271, where approximately twenty pounds of oil was used per ton of ore with the Timber Butte Mill figures for the same quarter for its oil flotation on the similar Elm Orlu ore, as given in plaintiff's Exhibit 249, and state which is the better, metallurgically, and why?

A. I have tabulated together the results of the first quarter of 1917.

Q. 10. And you produce a tabulated statement?

A. I have it here.

MR. KENYON: The plaintif offers the tabulated statement produced by the witness in evidence.

Statement admitted in evidence and marked Plaintiff's Exhibit 275.

Q. 11. Will you please explain this tabulation and interpret the results for us?

A. In the top set of figures, they are divided into two sets by a line in the middle; I have the Timber

Eltoft Wray Wilkinson.

Butte Mill results tabulated. In the lower set the Butte & Superior results.

Q. 12. From Exhibit 249?

A. Yes, from Exhibit 249. In the lower set I have the Butte & Superior mill results as taken from their sworn statements.

Q. 13. For the months of January, February and March, 1917?

A. Yes, sir. The second column shows the products, considered in the tabulation, the feed to flotation, flotation feed it is written here; flotation concentrate flotation tailings given and flotation tailings calculated. That is the same for both sets of figures. The third column shows the tons of material coming under these headings and the fourth column shows those same tonnages reduced to the basis of 100 tons flotation feed for comparative purposes, so that we can compare them for an equal amount of feed.

Q. 14. In the case of the Timber Butte Mill the concentrate is a little over 25 per cent of the total weight of the flotation feed?

A. 25.643 per cent.

Q. 15. And the tailings are a little under 75 per cent?

A. Yes, sir.

Q. 16. And in the other case?

A. 22.514 per cent is the weight of the concentrate.

Q. 17. As against?

A. Against the weight of feed.

Eltoft Wray Wilkinson.

Q. 18. As against what for tailings?

A. 77.486.

Q. 19. That is simply a convenient way?

A. It is a convenient way of comparing these results, starting from a common basis. The next column is the assay of zinc, percentage of these products tabulated here showing that in the Timber Butte Mill the average feed assayed for the first quarter of 1917, 14.295 per cent zinc.

Q. 20. What was the Butte & Superior?

A. That was 12.793. The concentrate assay in the Timber Butte Mill was 54.474 per cent zinc as compared with 47.228 per cent of the Butte & Superior Mill and the tailings assay given for the Timber Butte Mill was 0.714 per cent zinc as against 2.192 per cent of zinc given for the Butte & Superior Mill. That is calculated from the figures of each of these months, the weight of tailings and the assay of tailings presumably multiplied together and added and averaged.

Q. 21. When you say "given" that means that the figures are given in sources from which you have taken them?

A. The sworn statements, yes.

Q. 22. Now, what is that last figure under the column "assay zinc per cent" that last figure in each case? "Tails calculated?"

A. I will be able to explain better that last figure after considering the next column I think.

Q. 23. All right, explain it later then.

Eltoft Wray Wilkinson.

A. The next column shows the tons of zinc in the products obtained from these operations, assuming the operations to have been carried out on 100 tons of ore in each case. That is based on this percentage in the column of percentages. It shows that in the Timber Butte Mill in the feed ~~out~~ of 100 tons of feed there were fed 14.295 tons of zinc. In the concentrates there were recovered of this 13.969 tons of zinc, and in the tailings there were lost .0531 tons of zinc.

In the Butte & Superior Mill out of 12.793 tons of zinc fed in with 100 tons of flotation feed there were recovered in concentrates 10.632 tons of zinc and lost in the tailings according to the amount given 1.698 tons of zinc. Now, taking these figures we find that the sum of the tons of zinc in the concentrates and in the tailings adds up to not the same as the total tons of zinc in 100 tons of feed. And that might be due to an error in assaying or handling of samples or a number of errors might creep in there, and also it is harder to get a good assay on a low grade sample than it is on a high grade sample.

Q. 24. That is the tailings assays are harder to take accurately than the concentrate samples or the heading samples?

A. Or the heading samples, yes. The figures given as tailings calculated along the line starting "tailings calculation——"

THE WITNESS: On the line starting "Tailings Assay .326" is the difference between the tons of zinc

Eltoft Wray Wilkinson.

in the concentrates and tons of zinc in the feed; in the first place 14.295, in the latter 13.969.

Q. 25. That is, assuming the accuracy of the assay of the feed as containing 14.295 tons of zinc, and the assay of the concentrate as containing 13.969 tons of zinc, there could have been only .326 tons of zinc in the tailing?

A. That is all there could have been.

Q. 26. That is all the zinc that was left?

A. Yes; the rest of the metal was in the concentrate. Now, the same way with the Butte & Superior figures I find, assuming the accuracy in the zinc assay of feed and concentrate, that the concentrates do not account for 2.161 tons of zinc, and as in mill operations there are two outlets for metal, the tailings and the concentrate, once it has got into the mill, we assume that it has gone into the tailings.

Q. 27. So that in that case if the Butte & Superior mill, as in the other case, if the assay of the flotation feed was correct, namely that 100 tons contained 12.793 tons of zinc, and if the assay of the concentrate was correct, that 100 tons of feed gave the concentrate 10.632 tons of zinc, then there were 2.161 tons of zinc unaccounted for, which must have been lost in the tailings?

A. Yes. Now, taking the defendant's figures for the tons of zinc in the tailings from the treatment of 100 tons of ore and distributing that figure—for instance, in the Timber Butte case, distributing that .326 tons of zinc through the 74.357 tons of tailings,

it gives us an assay of .438%, which has been put down here as the calculated assay.

Q. 28. And in the case of the Butte & Superior the corresponding calculated assay of the tailings in the zinc would be what?

A. 2.789% of zinc calculated in the same way.

Q. 29. That is to say, if I understand you correctly, given the percentage of zinc stated in each case in the heading, and the percentage in the concentrate, and the tonnages given for those two, the tailings must have carried in the case of the Butte & Superior, 2.789% of zinc and in the case of the Timber Butte .438% of zinc.

A. They must. Now, the next column is the recovered per cent of zinc in flotation products, by flotation feed and concentrate; that is, assuming that the amount of zinc as determined by assay in the feed is correct and the amount of zinc in the concentrates is correct, taking into account the weight of concentrates produced, the per cent produced from the feed, we find that 97.72% of zinc in the case of the Timber Butte mill was recovered in the concentrate.

Q. 30. And the corresponding figure in the case of the Butte & Superior?

A. 83.11%. Now, the next figure, 3.7 there, stands for the recovery in the tailings, assuming the given assay figure to be correct.

Q. 31. You don't mean the recovery in the tailings; you mean the percentage in the tailings?

A. Well, the percentage of zinc in the tailings; it

Eltoft Wray Wilkinson.

is lost, it is gone to waste, but it is figured in the same way as the recovery in the concentrates, and that is why I used the word. We find that 3.71% of the zinc went into the tailings.

Q. 32. Figured on the tailings assay?

A. Figured on the tailings assay as given. We also note that the addition of this 3.71, the percentage of zinc in the tailings, to the 97.72, the percentage of zinc in the concentrates, amounts to more than 100%.

Q. 33. It amounts to 101.43%?

A. Yes. That is merely confirmatory of what I said before as to the tons of zinc left in the tailings; it shows that if we take that tailings assay, .714, we again have more zinc than we actually had in the feed, which is impossible.

So the next figure, 2.28, shows the percentage of zinc lost in the tailings, figured on the calculated assay, .438% zinc, and that figure, plus 97.72, takes you up to 100%. In the same way on the Butte & Superior figures we find that according to their assay—that is, the assay computed form their figures—taking the tonnage of the tailings for each month and the assay given for that month—we find that 13.27% of zinc was carried away or lost in the tailings. I have already mentioned, the recovery in the concentrates. These two ~~facts~~ foot up to 96.38.

Q. 34. They do not reach 100?

A. No.

Q. 35. Three or four per cent of the zinc is unaccounted for?

Eltoft Wray Wilkinson.

A. A little over 3½% is unaccounted for. The next figure, 16.89, is the percentage of zinc carried away in the tailings, assuming that that unaccounted for metal has gone into the tailings and was lost. There is no justification for thinking that it would go anywhere else, so we assume that it went into the tailings, as we did with the Timber Butte figures.

Q. 36. In the last column?

A. In the last column we have calculated—tabulated the percentage of recovery of zinc in the flotation products, the flotation concentrate and tailing; that is, we disregard the original feed assay and we assume that our concentrate assay and the tailing assay are correct, and assuming that these assays we have here are also correct, from the weights of the concentrates and the assay of the concentrates, and the assay of the tailings and the weights of the tailings we find the total amount of the metal present in the concentrates and tailings. Adding those up and proportioning them between the two products, we find that in the case of the Timber Butte mill 96.34% of zinc was recovered in the concentrates on that basis, and 3.64% was lost in the tailings.

Q. 37. And in the case of the Butte & Superior——

Q. 38. BY THE COURT: Where was the rest of it?

A. That ~~facts~~ foots up to 100%, or 99.98; that is simply a case of where the subsequent decimal figure here has been disregarded in tabulating these. In the case of the Butte & Superior figures, we find, figured

Eltoft Wray Wilkinson.

on the same basis, that 86.23% of the zinc was recovered in the concentrates, and 13.77% was lost in the tailings.

Q. 39. Of those two methods of figuring the recovery, which, in your judgment is the more reliable and safer?

A. I would prefer the former method given in the last column but one.

Q. 40. That first method, as I understand you, takes the total zinc in the feed and compares it with the total zinc actually recovered in the concentrates, and charges off as loss the difference between the two?

A. What is not recovered in the concentrates is charged off as lost.

Q. 41. What is not recovered in the concentrates is gone?

A. Because the object of the process is to make concentrates out of a given amount of ore, and we judge our success by the amount of concentrates we make.

Q. 42. And since there must be an assay in each case, first of the feed, second of the concentrates, and third, of the tailings, which of those three are more likely to be correct and reliable, the first two and the calculation figured on the first two, or the second and third and the calculation figured on the second and third?

A. It is more likely to be accurate to figure on the first two than the second and third.

Q. 43. Now, what is your conclusion as to these

two operations, the one at the Timber Butte mill and the other at the Butte & Superior mill; which is the better metallurgically?

A. In my opinion the result obtained at the Timber Butte mill as shown in these figures is better considerably than the result obtained at the Butte & Superior mill, as shown by these figures.

Q. 44. Notably better, you would say?

A. I should say notably better.

Q. 45. The concentrate produced at the Timber Butte mill is of a grade of 54.474, is it?

A. Yes.

Q. 46. And the concentrate produced at the Butte & Superior mill is of a grade of 47.228?

A. Yes.

Q. 47. The recovery figured in the best way you know of, made at the Timber Butte mill, is 97.72, is it?

A. Yes.

Q. 48. And that at the Butte & Superior mill is 83.11?

A. Yes.

CROSS EXAMINATION.

BY MR. SCOTT:

X-Q. 49. Will you give it as a general statement, Mr. Wilkinson, that the accuracy of the sampling and assay results increases as the values in the sample increases?

A. Not as a general statement, no.

(Witness Excused.)

Parker C. McIlhiney.

PARKER C. McILHINEY, after being duly sworn as a witness for plaintiff, testified as follows:

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 1. Please state your name, age, residence and occupation?

A. My name is Parker C. McIlhiney; I am 46 years old; I reside in New York; my occupation is that of consulting chemist.

Q. 2. State briefly your education and qualifications.

A. I was educated at the School of Mines of Columbia University as a chemist, and after I graduated I remained for some post-graduate work, which led to a degree of doctor. Then I went into the practice of chemistry as a profession, and I have been in that practice since about 1895, with offices in New York. I gave, during my studies at college, special attention to the chemistry and to the technology of fats and oils, and have done considerable professional work in that line.

Q. 3. Did you do the analytical chemical work for the plaintiff in connection with the trial of the case of Minerals Separation, Limited, against Miami Copper Company?

A. I did.

Q. 4. Have you made chemical examinations and analyses of the specimens brought to you from Salt

Lake City by Prof. Fulton and party, marked as samples obtained at Utah Copper Company, Magna plant?

A. I have done so

Q. 5. I now show you plaintiff's exhibit No. 253, and ask you whether or not you made the determinations under the heading "Percentage Copper" in that table.

A. I did.

Q. 6. Are they or are they not accurate determinations of the copper percentages of the products examined by you?

A. I believe they are accurate.

Q. 7. I call your attention also to the figures in the column headed "Oil Upon Products." Did you make those determinations?

A. I did.

Q. 8. In your determinations you have as the first item, "Concentrates Vol." which I understand to be volatile, ".67%." Then, "Non-V" which I understand to be non-volatile "2.14%; total, 2.81%." Will you explain the meaning of that description of your results?

A. I described the results of the analyses that I made of these products in this way, giving separately the percentage of volatile oil and of non-volatile oil, simply because, in carrying out the determinations, I considered it safer and more accurate to determine first the volatile oil which was upon the samples, and having removed that, to proceed to the separate determination of the non-volatile portion. I simply reported these results in the form in which I obtained them.

Parker C. McIlhiney.

Q. 9. And where would the line be drawn as between volatile and non-volatile in view of the character of your determination?

A. That line would be drawn by counting as volatile oil the oil which could be removed from the product, ore or tailings or other products, by heating it in a current of steam to a temperature of about 130° C.

Q. 10. Now, have you made a comparison between the results obtained by you and the results reported by the Utah Copper Company, Arthur plant, and appearing in defendant's exhibit No. 251?

A. I have made such a comparison.

Q. 11. Now, in the determination that you have made as to the percentage of oil in the concentrates, your figure is 2.81%, is it not?

A. It is.

Q. 12. Now, what is the figure of the Utah Copper Company?

A. The figure which is reported by the Utah Copper Company is, as I understand it, the percentage of oil contained in the mixture of concentrate and oil. I have calculated my results in terms of the percentage by weight which the oil bears to the solid matter upon which it is carried, so as to make my report uniform throughout, both as to the amount of oil added to the ore in the feed, and as to the amount of oil found upon the products. I understand that this report is calculated the other way, but I have calculated from the figure given by the Utah Copper Company that,

Parker C. McIlhiney.

on the same basis of the calculation that I used, the oil would be 2.40%.

Q. 13. That is to say, their figures "Combined Concentrate" which reads "Oil Analysis, Total Weight of Sample," and the figures "Total Weight of Oil Contained" and the figures, "Pounds of Oil per Ton, 46.88," you interpret as meaning that there is 46.88 pounds per ton, the total weight of the oil and solid matter?

A. I understand it so.

Q. 14. And making the correction or alteration to correspond to your method of computation, what percentage do you find?

A. 2.40%.

Q. 15. And what was your computation?

A. My result——

Q. 16. Your result, I mean.

A. My result as reported was 2.81.

Q. 17. Now, what is the next figure or determination of yours which you have just compared to the return of the Utah Copper Company?

A. The tailings.

Q. 18. In the Utah Copper Company report there is "No. 11 Tailing Sample, Cut No. 1—No. 11 Tailing Sample, Cut No. 2." Did you ascertain these separately or together?

A. No; I mixed the whole sample together and then examined it.

Q. 19. What was your determination as to the copper first?

Parker C. McIlhiney.

A. On the tailings I found .20% of copper.

Q. 20. And the report of the Utah Copper Company gives what for No. 1?

A. .165% copper.

Q. 21. And for No. 2?

A. For No. 2, .145 copper.

Q. 22. Now, are you satisfied of the accuracy of your determination?

A. I am satisfied that the assay that I made of the sample~~s~~ that I received is accurate.

Q. 23. And the discrepancy, is it or is it not larger than it ought to be for samples of the same product?

A. It is much larger than it should be for fairly taken samples of the same product.

Q. 24. Now, as to the oil determinations, can you resolve the figures of Utah with your method of determination?

A. I can, and when the calculation is made it shows that for the portion of the tailings sampled just described as Cut No. 1, where the report gives in pounds of oil per ton, 6.60—that corresponds by the method of description of the results which I have used to .33%; and in the case of Cut No. 2, the number of pounds of oil per ton reported there, which is 5.75, corresponds to .29%.

Q. 25. And what is your determination as to the total of the two cuts?

A. I find .199 per cent of oil on the tailings, the two samples having been mixed before examination.

Parker C. McIlhiney.

Q. 26. Here again is there or is there not a variation such as would not be ordinarily expected?

A. The variation is considerable and I think is larger than would be expected to occur between two similar analyses of exactly the same sample.

Q. 27. And, as to your determination, are you or are you not satisfied as to the accuracy of it?

A. I am quite satisfied that the oil determination that I made upon the sample that I received was accurate.

Q. 28. Now, what is the next comparison to make?

A. The skimmings of the first spitzkasten.

Q. 29. And that I take it is described as machine No 1 spitzkasten, No. 1 overflow in the Utah Copper Company report?

A. Yes. I understand that is the way they describe it in their report, the same material that I have described under the name of skimmings of first spitzkasten.

Q. 30. Now, make the comparison of their figures and yours?

A. As to the copper, the Utah Copper Company reports 19.1 per cent, whereas I have found 19.7 per cent. As to the oil, they report 412.31 pounds of oil per ton, and which calculated into the same shape as the results that I have, would be 25.97 per cent, and my figure refers—my figure for the same determination on the same material is 26.24 per cent.

Q. 31. The difference between these determinations

Parker C. McIlhiney.

as to copper and oil is not a large or unusual difference, is it?

A. Well, the difference in copper seems to me much more material than the difference in the oil.

Q. 32. Would you expect such a variation from a careful determination from the same character of material?

A. I think that samples of concentrates, if sampled perfectly accurately ought to agree more closely than these do in copper.

Q. 33. Now, what is the next figure, concentrate from the second spitzkasten?

A. Yes.

Q. 34. Please make a comparison of these?

A. On this product the Utah Copper Company reports a content of copper 21.25 per cent, whereas my result is 21.75 per cent. The amount of oil which they report, transformed into percentages on the basis that I have used, is 5.08, whereas I find in this product 4.97.

Q. 35. Were you one of the party representing the plaintiff which visited the plant of the Butte & Superior Mining Company on April 29th during this trial?

A. I was.

Q. 36. What in particular were your duties at that inspection?

A. My duties on that day were to receive from the representatives of the Minerals Separation who took samples the samples as they were prepared and to

seal them and to make a record of them and to see that they were brought to my laboratory safely.

Q. 37. Did you make determinations from the specimens that were thus obtained?

A. I did.

Q. 38. I now show you plaintiff's exhibit 252, and ask you first whether or not you made a determination of the percentage of sharps and slimes in the concentrates and tailings which were of these specimens?

A. I did.

Q. 39. In what manner did you determine what were sharps and what were slimes?

A. By taking the whole sample as received, being suspended in water and stirring it up so that it was uniform and allowing it to settle for one minute and then drawing off the slime, leaving behind the sharps which had settled.

Q. 40. And the percentages stated in this table are those that you arrived at by that method of determination?

A. Yes, the figures given for the weight of concentrate slimes and concentrate sharps are related to each other in exactly the way in which I found them to be.

Q. 41. Have you separated the sharps and slimes? Did you separately assay those different products.

A. I did.

Q. 42. And are the facts given in this table those that you determined?

A. Yes, they are.

Parker C. McIlhiney.

Q. 43. And did you make any determination of separated products?

A. Yes, I did.

Q. 44. And are those the figures of this table?

A. Yes, they are.

Q. 45. The separation into volatile oils recovered and non-volatile oils recovered was or was not that made in the same manner as in regard to the Utah specimens?

A. It was with regard to several of the Utah specimens, but I did not separate the volatile from the non-volatile in all of the Utah specimens. In other respects they were the same method of examination.

Q. 46. In so far as these appear on this table and in the Utah table, the method is the same, is it not.

A. Yes.

Whereupon an adjournment was taken until 10:00 A. M., Monday, May 14th, 1917.

Monday, May 14th, 1917, 10 a. m.

MR. WILLIAMS: If your honor please, in this suit, as we started with the original pleadings four weeks ago today, I said to your honor that the issues as presented were validity and infringement by the defendant at or before the filing of the bill of complaint in October, 1913. We presented a very short opening case, establishing those facts from the viewpoint of the plaintiff, and the trial proceeded. The defendant proved that, since the first of January, 1917,

and since the decision of the Supreme Court of the United States in the Hyde case, it had continued its operations with the sole variation of the addition of considerable quantities of oil, and the very definite use of soluble frothing agents. The facts relative to those proceedings of the defendant have very fully appeared. In the course of the trial we filed a supplemental bill, and in that supplemental bill we brought in certain new parties, and I may say that under that supplemental bill all the facts as to title have been practically stipulated, insofar as they were not previously stipulated. In that supplemental bill we allege that the acts of the defendant which were instigated by the defendant Hyde or started by the defendant Hyde, have continued, and of course the meaning of that is that they continued up to the time of the filing of that supplemental bill of complaint.

Then in connection with the matter of the disclaimer, we made, in the supplemental bill a charge of infringement, and that was a general charge of the continuance of the infringement up to the time of the filing of the supplemental bill of complaint. Upon careful scrutiny of that supplemental bill it seems to us that the definite charge of infringement of the other claims, which were charged to be infringe~~ment~~d in the original bill, claims 1, 2, 3, 5, 6, 7 and 12, they should be incorporated in the supplemental bill, to squarely present the issues that have been in fact raised by the evidence in this trial—therefore we ask leave of court to amend the supplemental bill of complaint which I now hand your honor, by inserting in clause 7 thereof, line

3 from the bottom, after the word "disclaimer," the following: "As well as claims 1, 2, 3, 5, 6, 7 and 12 of said letters patent", so that the clause reads: "That the processes recited in claims 9, 10 and 11 in said letters patent 835120, as limited by said disclaimer, are new and original inventions of the patentees thereof; and said claims 9, 10 and 11 of said letters patent 835120 as limited by said disclaimer are good and valid and that the Butte & Superior Mining Company had, subsequent to the issue of said letters patent No. 835120, and prior to the filing of the bill of complaint herein, and without the license or allowance of the plaintiffs or either of them, employed processes of concentrating powdered ores covering and containing said invention and inventions, in infringement of claims 9, 10 and 11 of said letters patent 835120, as well as claims 1, 2, 3, 5 6, 7 and 12 of said letters patent, and continues so to do, and has encouraged and induced others so to infringe." I would change that word "continue" to "continues". I informed the defendant this morning of our intention, so as not to make it a matter of surprise.

MR. KREMER: We desire to object to the amendment at this time as untimely. It certainly comes at a very late hour, and we object to it particularly for the reason that it entirely changes the cause of action attempted to be set forth in the supplemental bill of complaint. Reducing it to simple language, we find that in the supplemental bill which was filed over objection, as your honor will recall, there was an allegation of continuing alleged infringement of claims 9,

10, and 11, those claims of the patent which had to do with the use of more than one per cent of oil. The purpose was, as set forth in the supplemental bill, to confine it to those particular claims in order that they might raise an issue upon those claims which they omitted to disclaim. Now, after having so framed their pleading, they desire to amend them so as to extend it to all those claims of the patent which are entirely without the purview of claims 9, 10, and 11, the claims with reference to which the pleading was originally drawn and intended to be drawn. I believe that I can make the statement quite that strong, "intended to be drawn," because of the fact that the allegations immediately preceding are the allegations having to do with the disclaimer of this particular claim, and all of the disclaimer is set forth there by way of inducement to the particular part of infringement of 9, 10 and 11. So it seems to me, that if we are to construe the paper as it is drawn, that we can reach no other conclusion than that the cause of action attempted there to be set forth is a cause of action for the infringement of these particular claims which they allege that they disclaim. So, we object to it for that reason; and in addition to that we would interpose the same objection that we interposed to the filing of the supplemental bill.

MR. WILLIAMS: May I read to your honor the other clause of the supplemental bill which brings in these continuing acts, although not quite as definitely as we want them. That is on page 8 of the supplemental bill commencing with line four.

MR. KREMER: That is a part of your amended

bill, isn't it? That is your amended bill of complaint, not your supplemental bill, and is so embodied in your amended bill under a notice that you served that it would be inserted in your amended bill of complaint upon a certain page and at a certain line. Page 8 is not a part of your supplemental bill. It is a part of your amended bill of complaint.

MR. WILLIAMS: The claim is that the process introduced by the said Hyde into the Butte & Superior Mining Company's plant was continued in use by the said company, the defendant here, by and through other employes and under other superintendence, and in other plants. That is the allegation. Now, that is all the more reason for not segregating, after such a trial as we have had and after the introduction of such evidence as we have had, for not segregating the cause of the continuance of infringed claims 9, 10 and 11 from the other claims which were originally charged to be infringed. The pleading as it stands, without this amendment, would seem to support that special issue, and it is deemed advisable by all means that the pleading should set forth the issues which the trial of this case has practically brought forward by proof of the facts brought forward by the defendant. Mr. Kenyon wants to say a word.

MR. KENYON: The original bill of complaint brought by the Minerals Separation, Limited, alleged infringement of all of the claims, 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12. When the other two defendants were joined by this supplemental bill they thereby joined

in this alleged charge of infringement of all the claims. They became a party to them without themselves specifically repeating the charge of infringement that the owner of the legal title, acting for itself and for them had made. Now, the disclaimer coming along did not have to be pleaded by supplemental bill at all. The authorities so hold. It may be pleaded and it may not be pleaded. It need not be pleaded. Had it not been pleaded, it would by operation of law nevertheless relate back to the original pleading of infringement of claims 9, 10 and 11. And that original pleading made three or four years ago, would, by operation of law, and by effect of the disclaimer, become a pleading that claims 9, 10 and 11, so subsequently limited by disclaimer, had been infringed prior to the filing of the bill. That is the legal effect of a disclaimer under the authorities, that it relates back to the time of issue of the patent, takes effect from the time of issue of the patent, and the claims affected by the disclaimer are in contemplation of law as if they had been disclaimed from the day the patent issued; and all cases of infringement are to be determined on that theory. So we need not at all have pleaded this disclaimer nor need we have in the name of the two new parties alleged anew an infringement that had been comprehensively alleged in the original bill. And that clause 7 therefore, in contemplation of law, adds nothing to the allegations of infringement of the original bill, excepting only the one item, the words "and continues so to do." That is to say, it adds to the allegation of the original bill that the act of infringement was con-

tinuing at the date of the filing of the supplemental bill. The allegation was that the act of infringement of these three claims as limited by the disclaimer was continuing. Now, the relation of these three claims as limited by disclaimer to the other claims is, as your honor has certainly held in dealing with this matter of disclaimer, that these three claims certainly cover and included in their original form what the other claims covered and included. They cover and include all of them.

And if they differ from these other claims, they differ only in covering more. Now, by disclaimer we have cut down that "more" to something less than it was originally, but still not to something less than these other claims. It still remains that these claims 9, 10, and 11 as limited by disclaimer are, if they differ at all from the other claims, broader than the other claims. Therefore, the allegation of infringement of these broader claims includes the allegation of infringement of the narrower ones, necessarily, in the nature of the case. And our motion merely is that that allegation of infringement there, the only now feature of which is the continuing of the infringement up to the date of the filing of the supplemental bill, shall be the comprehensive including, not only claims 9, 10 and 11 as limited by disclaimer, which are the broadest claims in the complaint, but also claims 1, 2, 3, 5, 6, 7 and 12, the narrower ones, if there be any difference. So that nothing new is introduced, nothing new of substance is introduced by the amendment we ask to be

permitted to make; and this merely brings the pleading to conform exactly to the proof.

MR. KRAMER: If your honor pleases, it seems to me that if the statement of counsel is to be taken as given, that that confesses that this application is an entirely useless application. That in itself would be a sufficient ground of objection. But the situation is this, briefly: I do not know whether your honor has examined these pleadings since we have amended them, and supplemental pleadings have been filed; if not, I can briefly state it this way: To the original complaint as filed, an application was made to file an amended and supplemental bill. The application was a joint application insofar as the amendment and the supplemental pleadings are concerned. Well, under the rule of practice, the amendment would have to be made to the original complaint. The supplemental complaint is, of course, as its name implies, something that follows afterwards; therefore, paragraph 8, to which Mr. Williams referred, being an amendment to the original complaint, was embodied in the original complaint under the rule of practice by notice that that should become a part of the original complaint at a certain point and place. And that was done. Therefore parapragh 8 of their application, the paragraph to which Mr. Williams refers, was made a part and was an amendment to the original complaint. Now that left the supplemental complaint a separate and distinct pleading. Now, in that supplemental complaint, the supplemental complaint having to do only with those

things which had transpired since the filing of the original complaint and applying the rule that Mr. Kenyon has set forth that the disclaimer relates back to the time of the issuance of the patent, and of course that would be at a time preceding the filing of the original complaint—therefore we find that in the supplemental complaint as filed, a separate and distinct ground of recovery was set up. We argued that at the time, and that was filed.

Now, in that supplemental bill of complaint they specifically confine themselves to the use by the defendant of claims 9, 10 and 11. It is all very well for these gentlemen to say that of course the original complaint covers it all. If it covers it all, then they should be satisfied. But the difficulty is this, and we might as well meet the crux of the situation—that perhaps they have some fear of the application of the rule of "Expressio unis, ulterior exclusio est." I think that is the correct quotation.

MR. WILLIAMS: Very fine; very fine.

MR. KREMER: The expression in that supplemental bill of one particular act is to the exclusion of every other act, and now that is the situation that is presented to your honor, and I believe that that is the legal effect of it. Now, the question is, can they change their supplemental bill so as to show or to change their cuase of action to cover that which they had no intention of covering, if we are to judge from their pleadings, at the time that their application was made to file that supplemental bill. Now, I think that

is the situation. I do not know that I can add anything further to the statement than that it is a mere simple statement of law and fact.

THE COURT: Let us see where we are at. If we have been sitting here four weeks trying claims 9, 10 and 11, instead of the whole patent, it is time the court understood the fact. It has been understood that we were trying the whole patent except Nos. 4 and 8, I think it is. Your purpose is to incorporate in paragraph 7, claims 1, 2, 3, 5, 6, 7 and 12, which your fears incline you to believe may not be there?

MR. WILLIAMS: Yes, your honor.

THE COURT: And your understanding is that we have been trying those?

MR. WILLIAMS: Yes, your honor.

THE COURT: And you think you have been trying only 9, 10 and 11?

MR. KREMER: No, your honor, I can not say that; I would not make that statement. I say that on these pleadings we have been trying all the claims of this patent except insofar as the allegations of that supplemental bill limit ~~to~~ them to the right to try them. In other words, since the disclaimer was filed and since the decision, we know that the Supreme Court of the United States declared them invalid; therefore I think that under these pleadings we have a right to assume that in the continued user of that process under the pleadings should be limited to 9, 10 and 11; they allege that we have continued to use it at all times.

THE COURT: Yes, I see. Your contention is that we have been trying it as far as the user is concerned, under claims 9, 10 and 11.

MR. KREMER: Your honor understands that under these pleadings—confining it to the pleadings, for I do not want to make a general statement——

THE COURT: Well, you think they are fearful, and perhaps they are. Well, it might be useless, but it is an ancient and unalienable right to cast out anchors to windward, for counsel to take precautions and to multiply pleadings and words for fear there might be some loophole through which the opposite party might escape and the pleader be hurt. It is in line, of course, with the safety-first theory, to make sure; and so, it is for the benefit of the court as well, so that the court will not be compelled to try this case over again. I certainly do not want to try this case again.

Everything has proceeded very harmoniously, counsel have made less difficulties than we have often seen in this court, and perhaps the court has made less trouble; but I do not want to go over this ground again; I want it all tried here and now. It can not be any element of surprise. I think we all understood that these claims, 1, 2, 3, 5, 6, 7, and 12, were being tried. I realize now for the first time that 9, 10 and 11 are being tried; I thought 9, 10 and 11 were excluded. I must have misunderstood the language of counsel, for I certainly understood that 9, 10 and 11 were excluded from consideration, and I certainly

understood that 1, 2, 3, 5, 6, 7, and 12 were being tried. So this amendment is in line with making it clear and explicit now, so we will not have to try it again, therefore the amendment will be allowed and an exception may be noted.

(Defendant excepted.)

MR. KREMER: At this time, without redrafting the pleadings, I will ask if we may insert in the original a line which is in accordance with the pleading. I do not want to say "denial," because I don't know just what it will be, but I want to interline the amendment to keep from redrafting the whole pleadings, which are voluminous.

THE COURT: Very well; if you make an amendment by interlineation, you can do that, but before you do it you had better call it to the attention of the other side and submit it to the court so that it will be understood.

MR. KREMER: Yes, your honor, we will submit it. We will present it to the clerk and have him initial it.

THE COURT: Very well.

DR. McILHINEY, recalled for further

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 49. Dr. McIlhiney, additionally to the determinations made by you of specimens of the—from the Butte & Superior mill that are set forth in plaintiff's

Parker C. McIlhiney.

exhibit 252, have you made a determination of the zinc and oil contained on the tailings from cleaner No. 2?

A. I have.

Q. 50. What was your determination?

A. I found in those tailings 8.60% of zinc and 2.02% of oil.

Q. 51. You may state what the corresponding determination by the Butte & Superior Mining Company are as they are stated in Exhibit 227.

A. Where I found 8.60% of zinc, they report 8.65%; where I report 2.02% of oil they have 2.24%.

Q. 52. BY THE COURT: More than yours?

A. Yes, sir.

Q. 53. MR. WILLIAMS: Have you found any general relation of their oil determinations to your oil determinations?

A. I have not. Sometimes, as I recall them, they are higher and sometimes they are lower, though the totals agree fairly.

Q. 54. BY THE COURT: Let the court be clear on this. Is this the tailings from cleaner No. 2?

MR. WILLIAMS: Tailings from cleaner No. 2 which was sent to waste; 8.60% of zinc.

THE COURT: Proceed.

Q. 5~~4~~5. MR. WILLIAMS: Did you make any examination of the pulp obtained from defendant's mill, for the purpose of determining whether or not there was pine oil in the pulp?

Parker C. McIlhiney.

A. I did.

Q. 56. And what did you find?

A. I found that there was pine oil.

Q. 57. Have you made examination of the pine oils supplied by the defendant to determine whether or not they contain a soluble frothing agent?

A. I have made such determinations.

Q. 58. And do you find that the pine oil, besides containing a soluble frothing agent, contains insoluble material?

A. Yes; the pine oil contains both soluble and insoluble portions.

Q. 59. Did you examine specimens obtained from the defendant of an operation performed in court by Dr. Sadtler in a gabbett, said to represent the disclosure of the California Journal of Technology?

A. I did examine such a specimen.

Q. 60. What did you find as to the copper content—it having been stated that the ore was a copper ore?

A. I found that the ore itself contained .85% of copper; that the concentrate contained 2.33%, and that the tailings contained .59%.

Q. 61. And what was the recovery, on those figures?

A. That would indicate a recovery of 40.96%.

Q. 62. Did you examine the specimen of kerosene oil supplied by the defendant as corresponding to that used by Mr. Phillips in his 25% kerosene oil experiment made in court?

Parker C. McIlhiney.

A. I did.

Q. 63. What was your examination and what did you find?

A. I found that it contained a soluble frothing agent, and I separated that frothing agent from the main body of the oil by dissolving it in water, and examined the water separately, and found that it gave every evidence of containing a soluble frothing agent.

Q. 64. Did you make any concentration?

A. Yes; I not only examined the water solution itself, but I concentrated the ingredients into a smaller volume by distillation or by rectification, and found that the liquid when concentrated gave more marked indications than the original water solution from which that rectified material was obtained.

Q. 65. Was there any odor about it?

A. Yes, there was. The water, after having been separated from the kerosene, carefully, had an odor which was entirely different from that of kerosene, which was rather indeterminate in character, but I should be most inclined to refer it to some kind of pine oil or some trace of wood product.

Q. 66. Did you examine the specimen of kerosene or petroleum distillate supplied by the defendant as corresponding to that used by Mr. Dosenbach in his experiment with 25% of kerosene, said to represent the Kirby patent?

A. I did, and I found the material to show qualita-

tively the same character as the kerosene sample that I have just described.

Q. 67. That is to say, what did it contain?

A. A soluble frothing agent.

Q. 68. Did you make any tests of the Butte & Superior oils for the purpose of determining the presence or absence of grease?

A. I did; I examined the oils which I had extracted from the various products, and I found that they all contained a large proportion—say from between one-half to two-thirds of a solid grease. I examined this solid grease particularly in the case of that obtained from the slimes of concentrates, and I found that it had a melting point of approximately 36° C., and that in that case it constituted 47.6% of the whole of the oil which had been extracted from those concentrate slimes.

Q. 69. I have computed as 97° F. about; will you accept that computation?

A. I will not dispute that computation.

Q. 70. Did you separate this solid material?

A. I separated it in the course of the analysis that I made of all these Butte & Superior materials.

Q. 71. Have you a specimen with you?

A. I have. (Producing small bottle.)

Q. 72. I note that you have marked upon the bottle containing this specimen "non-volatile oil recovered from slimes concentrates, defendant's plant, April 29th, 1917." Is that a proper description of this specimen that you have produced?

A. It is.

MR. WILLIAMS: I offer the specimen in evidence.

Specimen admitted without objection marked PLAINTIFF'S EXHIBIT No. 276.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 73. Could you say, or do you know that the solid grease you say you got from the concentrate slimes was not adsorbed at the surface of the bubbles and therefore not active in the flotation operation?

MR. WILLIAMS: It rather seems to me that the question covers a scientific theory of the operation as carried on, and the witness has come here and told us of the results of the examination of the products only. It seems to me the scope of the question is beyond that of the direct examination, and that it is inadmissible.

MR. SCOTT: I think I will accept your honor's ruling without argument.

THE COURT: It seems to me that that is so: anything within the range of the direct examination, of course, is proper, or anything within the range of the science disclosed in this examination. It seems to me now that you are going into the practice and theory of flotation, while this gentleman testified only

as to the results of certain assays. The objection will be sustained.

Defendant excepted.

MR. SCOTT: No further cross examination.

DR. WILLIAM MASON GROSVENOR, Recalled, testified as follows:

DIRECT EXAMINATION.

BY MR. WILLIAMS:

Q. 1. Dr. Grosvenor you exhibited to the court certain moving pictures. Please state whether or not these pictures were prepared under your direction and supervision and in your presence; and in general whether you took precautions to see that the experiments of a reliable character and that they were accurately portrayed in the pictures?

A. Every such precaution was taken. No one of the pictures was taken out of my presence, and in nearly every case I participated in the actual operation, either manipulating the experiment or operating the camera. In some cases the work was of such a character that I preferred to have someone else do both of these things in order that I might watch with greater care exactly what was going on and be able to identify the accuracy of the picture presentation of it. There is no one of these pictures that does not correspond exactly with what I saw, so far as the quickness of the eye would permit it to be seen, and

P. 4706, L. 15, insert "portrayed by these moving pictures were experiments" after "ments"

William Mason Grosvenor.

not once but many times, because these experiments were all repeated in various forms in order to ascertain the methods which would most clearly photograph the thing we had learned to know occurred. When taken, the negatives were in every case marked for identification and in almost every case were developed in my presence. Having identified negatives it is always possible to identify with certainty the correctness of the positives prepared from those negatives.

Q. 2. And have you done so with these pictures?

A. That has been done; and, beyond that, the facts which the positives represent I know to have been the thing which occurred.

MR. WILLIAMS: I offer in evidence the moving picture films.

Picture films admitted in evidence and marked PLAINTIFF'S EXHIBIT 277.

MR. WILLIAMS: There is a stipulation which we made when the defendant showed magic lantern slides, that the film should remain in the custody of counsel, but we propose to leave these films with your honor during the time that the case is under consideration, because they may be separately examined with a magnifying glass for the purpose of determining any question.

Q. 3. Now, Dr. Grosvenor, did you attend the magic lantern exhibition of Prof. Phillips, and have you examined the photographs that were offered in evidence during his testimony?

William Mason Grosvenor.

not once but many times, because these experiments were all repeated in various forms in order to ascertain the methods which would most clearly photograph the thing we had learned to know occurred. When taken, the negatives were in every case marked for identification and in almost every case were developed in my presence. Having identified negatives it is always possible to identify with certainty the correctness of the positives prepared from those negatives.

Q. 2. And have you done so with these pictures?

A. That has been done; and, beyond that, the facts which the positives represent I know to have been the thing which occurred.

MR. WILLIAMS: I offer in evidence the moving picture films.

Picture films admitted in evidence and marked PLAINTIFF'S EXHIBIT 277.

MR. WILLIAMS: There is a stipulation which we made when the defendant showed magic lantern slides, that the film should remain in the custody of counsel, but we propose to leave these films with your honor during the time that the case is under consideration, because they may be separately examined with a magnifying glass for the purpose of determining any question.

Q. 3. Now, Dr. Grosvenor, did you attend the magic lantern exhibition of Prof. Phillips, and have you examined the photographs that were offered in evidence during his testimony?

A. I did both.

Q. 4. What have you to say generally as to those photographs?

A. That the photographic work was excellent and accurately portrayed what was seen under the conditions present; but that the conditions chosen for photographing were of a character that did not at all disclose the critical or important points with regard to the character or composition or the construction of the froth. That instead of representing a froth in layers of such thickness and so illuminated that it would be possible to judge anything about the construction of the froth, the conditions chosen for the photographs were those which would represent the surface similarity of the froth and give us no information as to their make-up. I would, therefore, regard them as having no technical value in deciding what the character of the froth was and certainly no value in deciding as to its recovery or composition.

Q. 5. There was a phenomenon to which attention was called when these photographs were exhibited, what I might call the "two spot" phenomenon? What have you to say in regard to that?

A. That I cannot attach any such importance to that as was indicated by Prof. Taggart's testimony because while the dual spot may possibly have been due to the reflect~~ion~~ed layer of oil on the inside of the bubble between the air and the metallic particle, I have made hundreds if not thousands of photo-

William Mason Grosvenor.

graphs of the actual interiors of the bubbles themselves, taken with the sectional bubble holder that was spoken of the other day, close up against the side of a cell so that I was able to photograph directly what was going on within the bubble, and it has been proven very clearly that just such reflections may be obtained from layers of particles where they can be seen quite clearly exposed to the air on the inside of the bubble with no modifying agent of any kind present in the mixture. In fact, one of the chief difficulties that I have so far been unable wholly to overcome, so as to secure satisfactory pictures for projection of just what is going on inside the bubbles, has been that there have been so many reflections, there have been so many difficulties in securing the absence of reflections from the film itself, what we call hallation effect, the brilliant glarey spots in pictures due to excessive light diffused from a point, I have been unable to eliminate. That I think is supported by each of the pictures themselves because they by no means exhibit a universality of two spots. In many cases there are more than two, and in some cases there do not seem to be any. The reflections from the interiors of such bubbles are extremely complicated, and as I say I have found it almost impossible to get simply illuminating effects.

Q. 6. Now, have you any photographs taken from parts of the films that you would like to put in evidence.

A. In connection with the question of oil and air

froths and particularly the photographic presentation of the froths that are shown as microscopic slides, I have selected a few of the pictures from the films for reproduction and enlargement in order to show that, properly taken, it is easy to see when illuminated from the rear a great deal of the actual structure of the froths themselves. That is not only clearly indicated by the projection on the screen, but is indicated where it can be more easily examined in these enlargements. In the air froth of which these five constitute the series, it is possible to see, when properly illuminated, not merely the face of the bubble but see through the bubble and judge to a great extent the location and character of attachment of the mineral particle when the froth was manipulated, as this froth was during the taking of the moving pictures, between glass frames, through the rear one of which the illumination was past and through the front one of which the picture was taken.

The numbers on the back of these photographs are rather algebraic, but A-1, A2, A3, A4 and A5 are the air froths. The numbers 1, 2, 3, 4 and 5, indicate the order in which they were selected as the froth was more and more manipulated. In a similar manner 01, 2, 3, 4 indicate the order of the pictures taken of the oil froths, the characteristic difference being that the oil froth does not show either the transparency between the granules of mineral on the bubbles or the attachment of the particles of mineral

William Mason Grosvenor.

to the edges of the bubbles during manipulation, as the air moved in and out of the froth.

Q. 7. Now, what does the photograph marked 04 show?

A. It shows the residue of oil entrapp~~ed~~ing mineral from which manipulation has enabled or caused sufficient of the air to slip away so that the buoyancy of the froth as a whole was not sufficient to support its load of mineral, and it corresponds roughly to the sinking portion of the Elmore float indicated in one of the pictures where the oil became overloaded by too much of mineral and dropped to the bottom. That is a photograph of this oil froth after the escape of a portion of the air dropping to the bottom and passing out of the frame work of the picture, beyond the reach of the lens.

MR. WILLIAMS: The photographs produced by the witness are offered in evidence.

Photograph O-1 admitted in evidence and marked PLAINTIFF'S EXHIBIT 278.

Photograph O-2 admitted in evidence and marked PLAINTIFF'S EXHIBIT 279.

Photograph O-3 admitted in evidence and marked PLAINTIFF'S EXHIBIT 280.

Photograph O-4 admitted in evidence and marked PLAINTIFF'S EXHIBIT 281.

Photograph A-1 admitted in evidence and marked PLAINTIFF'S EXHIBIT 282.

Photograph A-2 admitted in evidence and marked PLAINTIFF'S EXHIBIT 283.

Photograph A-3 admitted in evidence and marked PLAINTIFF'S EXHIBIT 284.

Photograph A-4 admitted in evidence and marked PLAINTIFF'S EXHIBIT 285.

Photograph A-5 admitted in evidence and marked PLAINTIFF'S EXHIBIT 286.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 8. Do I understand you, doctor, to say that these are reproductions from the moving picture films?

A. They are.

X-Q. 9. From the ones that were exhibited?

A. Yes, enlargements of certain individual pictures along the line and the numbers indicate—although not in equal division—they indicate the order in which these pictures succeeded each other somewhere in the line.

X-Q. 10. Then the set that you have marked with the letter "A," A-1 to A-5, they represent the same froth?

A. Air froth, yes.

X-Q. 11. And the same one?

A. The same one that is shown in the moving pictures.

X-Q. 12. And I have forgotten the amount of

William Mason Grosvenor.

oil that was used in making this air froth?

A. Do you want it accurately or approximately?

X-Q. 13. Oh, approximately.

A. About two-tenths of a per cent; merely a small amount.

X-Q. 14. And this other one as I remember was about 16 or 17 per cent?

A. Approximately that.

X-Q. 15. Do the moving pictures show any contrast between froths where the quantity of oil does not differ so much as in the case of these two sets that have just been introduced?

A. They do. I don't suppose you mean these particular ones because these particular ones were just of particular froths. But the same thing is shown in other pictures, the same difference, not in degree, not in the same way exactly, but the difference is photographed.

X-Q. 16. Now, in commenting on Mr. Phillips' pictures you stated that they were not taken in such a way as to exhibit the important characteristics of the froth. Now, I wish you would state what these important characteristics are?

A. From the indications in my experimental work it is quite important to know with regard to the froth whether there is a considerable excess of oil immediately associated in contact with the air and the mineral coming between the two. That could not, so far as I can see, be judged from these photographs.

William Mason Grosvenor.

X-Q. 16A. And that is the thing which I take it you regard as constituting the distinction between what you term an air froth and what you term an oil froth, namely, the amount of oil separating the mineral from the air contained in the bubbles?

A. In a sense, yes. In a mineral froth it is possible to judge whether the mineral is attached to the air bubble by such examination, and I think that attachment is the vital thing.

X-Q. 17. And in its final analysis this question of distinction in the mode of attachment resolves itself merely into what you referred to before, doesn't it, namely the thickness of the oil layer or the thickness of the oil intervening between the mineral particle and the interior of the bubble?

A. No, that does not by any means.

X-Q. 18. That is what I was trying to get at.

A. I think my testimony has made it quite clear that whether things do attach or do not attach is dependent upon the strain to which they are subject, the character of the materials between them, and in this specific instance the size of the particle. There are many of those conditions. But what I meant to bring out was that with the froth ~~the oil~~ under consideration, the reason for taking such photograph is that it shows the presence or absence of the oil, which is vital. That is, not merely the amount of oil which is poured into the system, but the amount of oil which is actually engaged in co-operative action between the bubble and the mineral. An immense amount of excess oil,

William Mason Grosvenor.

either useless or harmful may be put in. But by examination of the froth it is possible in my opinion to determine whether the effects of that oil has been injurious, provided the pictures are taken in the proper way.

X-Q. 19. Well, now, knowing that you do not profess to be conversant with metallurgical practices, allowing for that fact, but just as a matter of ordinary common sense wouldn't you think that the real test of whether the excess of oil was injurious and was interfering with the process would be the practical results obtained, namely the efficient recovery of a desired mineral.

A. If I were satisfied, as I am not by any means, I have testified to the contrary, that such oil as was put in might and must of necessity take part in the actual operation of flotation, I would be. But if you simply tell me that so many pounds of oil have been put into the system, and that you have made such a recovery, admitting that the recovery may be excellent, it does not follow that these oils were not capable of being injurious, if they had been left in a position to exercise their injurious function.

X-Q. 20. Well, the fact that we have assumed that the recovery is satisfactory would in itself be evidence, would it not, that the oil had been present in such a way as not to function injuriously?

A. If the recovery were satisfactory it would indicate to my mind that something had been done to prevent that oil from doing harm.

William Mason Grosvenor.

X-Q. 21. And, for instance, what might some of those things be that could be done to prevent the oil from doing harm?

A. Over aeration, and carrying it away in the bubbles, over agitation or emulsification or a number of things may cause it.

X-Q. 22. By "over aeration" I take it that you mean agitation sufficient to create enough bubbles to adsorb the oil?

A. That would be one way of putting it. Another way would be agitating it so as to offset the possible injurious effects of the excess oil.

X-Q. 23. Now, doctor, will you explain the mechanism that you used in getting the magnified bubble pictures which you exhibited in the motion pictures?

A. To simplify that explanation I took the liberty of making a sketch, which is very rough, but will illustrate the type of apparatus used and is something like—somewhat near about half size. The upper portion of the apparatus marked "A" is merely a chamber or box for receiving the liquid and providing a sort of reservoir for any excess or variation in the column that there might be with the entrainment of air. That in the particular apparatus used was made of wood painted on the inside with, as I recall it, an asphalt paint. I satisfied myself that it had no modifying action on the liquid by testing it. The part marked "B" consists of a flat rectangular column of optical plate glass of approximately the section shown through which the current of liquid

William Mason Grosvenor.

passed downward, and at the bottom of which there was the so-called bubble tube, or an alundum bubbling tube, which, consisted of a brass tube in the upper edge of which is a tube of alundum through which the air can be forced.

X-Q. 24. by Mr Williams What kind of material is alundum?

A. Alundum is a product of the Northern Abrasive Company, I think the name is, of Niagara Falls, and it is a fused oxide of aluminum. It was selected because of its great porosity and extreme fineness of its pores so that we could introduce air in very minute streams and ascertain the tendency to aggregate and coalesce, or on the other hand the action of the frothing agent in preventing ~~each~~ such coalescence. The choice of this particularly finely grained material was dictated by the fact that it is non-metallic in character and therefore the bubbles do not tend to gather and aggregate on its surface and produce what might be called false or premature coalescence. Well, returning to the diagram. Air pressure applied to the cell of the alundum tube marked "C" would cause the air to bubble up through the falling volume of liquid in the observing chamber "B"; and if nothing were done to prevent the rise of liquid in that column the air bubbles would tend to make that liquid rise. To overcome that tendency a continuous circuit was secured through the lower block of the apparatus "D," and a return pipe "E" of glass which served to carry the liquid back into the reservoir. The action of the pipe "E" gives rise for

the name attached to the cell, "the air lift cell" because by injecting air at the bottom—

X-Q. 25. MR. WILLIAMS: Mark the pipe through which air is injected.

A. By injecting air into the bottom of the column "E" through the pipe "F," it is possible to cause a continuous and even rise of the liquid in the column "E" and maintain an active circulation in the apparatus; and likewise possible to control the rate of that circulation so that the rising of the bubbles here in the column "B" could be retarded to a sufficient extent to permit us to get a series of photographs that would make the progressive approach and coalescence clearly visible in the moving picture. Unless we have about nine pictures of anything which is passing across the field of view, the pictures become jumpy and it is difficult, if not impossible, to follow the smooth progressive movement. That is the reason for selecting this method of observation, because it is tantamount to moving our camera upward with the bubble or moving the vessel of liquid downward against it.

MR. WILLIAMS: I offer the diagram prepared by Dr. Grosvenor in evidence.

Diagram admitted in evidence and marked

PLAINTIFF'S EXHIBIT 287.

MR. KENYON: To complete the matter of title, plaintiff's counsel offers in evidence the agreement

William Mason Grosvenor.

of July 8th, 1913, between Minerals Separation, Limited, and Minerals Separation American Syndicate, 1913, Limited, being Exhibit A attached to the supplemental Bill of Complaint, and the same is marked plaintiff's exhibit No. 288.

Document admitted in evidence as PLAINTIFF'S EXHIBIT 288.

MR. KENYON: Also a copy of the bill of sale from Minerals Separation American Syndicate, 1913, Limited, to Minerals Separation, North American Corporation, being exhibit B attached to the supplement, al bill of complaint and the same is marked Plaintiff's exhibit No. 289.

Bill of Sale admitted in evidence marked PLAINTIFF'S EXHIBIT No. 289.

MR. KENYON: It is stipulated that exhibits 288 and 289 may be received in evidence with the full force and effect that the originals themselves would have had?

MR. KREMER: Yes; you state that they are copies of the original?

MR. KENYON: Yes, they are copies of the exhibits attached to the complaint.

MR. KREMER: It is covered by the general stipulation, I believe.

JAMES WILDING, recalled for further

DIRECT EXAMINATION,

BY MR. KENYON:

Q. 1. MR. KENYON: Mr. Wilding desires to make a few corrections.

THE WITNESS: If your honor please, I would like to make an explanation in regard to the tables submitted on Saturday afternoon, and also to make two corrections in my answers to questions of counsel for the defendant.

Explanation of the tables. My four tables contain columns which were not used at all in arriving at the ultimate answer of results. They are the columns of Ratio of Concentration, the tons of tailings, and the assays of tailings. They are of interest as showing the degree of accuracy with which the operations leading to the figures on defendants Exhibit's had been carried out; but had they been omitted, the result would be the same.

The corrections I would like to make are in answer to Mr. Scott's questions Nos. 278 and 279, page 2653 of the transcript. In the first question, No. 278 was, "taken by reliable sampling means," and 279, "and assayed presumably by reliable assayers?" My answers to these questions was yes. I did not mean to express any opinion as to the reliability of the methods of sampling and assaying at the Chino

James Wilding.

mill. I don't know what those methods are. In a previous answer I had given an opinion that the work on which Mr. Wicks' figures were based must have been inaccurate, as they are not reasonably consistent with each other, and I could not say at what stage the work was inaccurate. My own work on these figures was pure arithmetic, as I explained, and is accurate.

In answer to Mr. Scott's question 288, I said "I can not express an opinion of the accuracy of the work." I was speaking of Mr. Wicks' figures, and not of my own, and meant that I could not express an opinion as to the accuracy of any particular portion of that work over that of any other. I had already stated that some portion or other of the work must be inaccurate.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 2. Referring to exhibit 255, Mr. Wicks' report, now for illustration, and to follow your method definitely, I wish you would take the entry for October, 1916, and simply show us your calculation for arriving at the horizontal line of entry opposite October, 1916. If you can do it upon a piece of paper or upon the blackboard there it will probably be better.

A. October, 1916; that is exhibit 29. Tons of flotation headings—

James Wilding.

X-Q. 3. If not inconvenient I think it would help us if you would make the calculation on the board.

A. All right, sir. I will do that. We have here from exhibit 29, 9794 tons of heading. The copper assay is given as 7.77%. Multiplying 9794 by .0777, you get the number of tons of copper in that heading. Multiplying that number of tons of copper by 2000 you get the number of pounds of copper in that heading. The number of pounds of copper in the heading, 1,521,988, that is multiplied by 2000, as 2000 pounds are contained in a ton. Tons of flotation concentrate given in exhibit 29 is 2884. The assay given is 26.03. Multiplying by .2603 and again by 2000 and we have the pounds of copper contained in the concentrate, which is 1,501,410. The relation between these two figures expressed in per cent gives us the calculated recovery figure; that is to say; this figure divided by that will give 98.65%. Is that satisfactory?

X-Q. 4. That is very clear, yes.

A. We have then the column of tons of tailings, which is simply by difference; 9794 minus 2884 equals 6910. Pounds of copper contained in tailings by difference again, 20,578.

X-Q. 5. BY MR. KENYON: You had better set above that last figure what it is.

A. Pounds of copper in tailings. Next, assay of copper calculated, which is obtained by dividing the pounds of copper by the tons of tailings, in which case we get the pounds of copper in each ton of tail-

James Wilding.

ings. I haven't the intermediate figure here, but of course to express it by per cent, you divide it by twenty. The result is .149% of copper in the tailings. The pounds of copper lost per ton of heading will be then 20,578 divided by 9794, which is 2.10. The value of that 2.10 pounds of copper at 20 cents—

X-Q. 6. Now, Mr. Wilding, unless the others desire to have it, you have gone far enough to illustrate what I wanted.

X-Q. 7. MR. KENYON: Write here what this is, pounds of copper in what, and also this.

A. Pounds of copper in heading and pounds of copper in tailing per ton of heading.

X-Q. 8. MR. SCOTT: Now, Mr. Wilding, just so that we may come to an understanding, the basis of your calculations when you started to make them was that these concentrates were actually weighed —wasn't it?

A. That was my idea, over any period of three months, for instance. On Saturday you referred to the third quarter—over any period of three months one does expect reports of the actual weights.

X-Q. 9. But there was a misunderstanding in that respect?

A. Yes.

X-Q. 10. And inasmuch as these concentrate weights do not represent actual weighing operations, you would not expect to be able to correct the tailing assays by this system of computation which you have used, would you?

James Wilding.

A. I would put it another way, Mr. Scott, if I may be allowed. By calculation from these assays of heads, concentrates and tailings, then we arrive at certain recovery figures; and then by using that recovery figure we arrive at a certain weight of concentrates produced. If that weight be wrong, then it is a necessary conclusion that the work on which the figures are founded is wrong at some one stage or portion of the total operations.

X-Q. 11. I understand.

A. Let us suppose that the computations are accurate. Now, one never does expect checks, that is, accurate—that is, absolute checks; that, of course, can not be. One does expect reasonable checks in calculating back. For instance, I will give you a case right here, which also is in evidence. Here we have a given assay for the first quarter of 1917 on exhibit 256 of .412% copper in the tailings. This is taken directly from defendant's exhibit 150, Ray Consolidated Copper Company. The assay calculated on the same basis as in the other exhibit is .439. That is a close check; that is a reasonable check; it shows that the work was properly done. This other figure above, that for the fourth quarter of 1916, the given assay is .273, and the calculated is .274. That is an unexpectedly good check; we can not expect any such results in practice on the whole.

Now, my whole position in regard to the other figures presented is that they are too inaccurate for

James Wilding.

recognition as regards the Chino; that they do not show what Mr. Wicks thinks they show when analyzed.

X-Q. 12. Did you have any particular reason, Mr. Wilding, in your computation upon the Chino report, for taking the cost per ton of copper instead of the cost per pound?

A. Cost per ton—I beg your pardon.

X-Q. 13. That is, you have given on the basis of the cost per ton rather than the cost per pound of copper.

A. I have not reckoned the cost per pound of copper; I have reckoned the cost of operations, including the operating cost, the cost of smelting concentrates and the loss referred to ton of heading, not referred to pounds of copper at all.

X-Q. 14. Was there any particular reason for taking it per ton of heading, rather than per pound of copper?

A. No, there is no particular reason, only the fact that it seemed the simplest thing for me to do. However, I should say that in the other way we take into account the value of the heading in copper, which I have endeavored to eliminate, as they are so different in the two periods under comparison, that one could not reduce them to a common basis for calculation; it is almost impossible. It becomes a metallurgical surmise.

RE-DIRECT EXAMINATION,

BY MR. KENYON:

of computation in all cases on exhibits 255, 256, 272 and 273 that you have explained to us here?

A. Yes.

MR. KENYON: Plaintiff's counsel puts the explanatory diagram of the witness in evidence, and it is marked plaintiff's exhibit No. 290.

DIAGRAM admitted in evidence marked PLAINTIFF'S EXHIBIT No. 290.

WITNESS EXCUSED.

MR. WILLIAMS: If your honor please, at the time of the proof by the plaintiff of the licensees and the returns from our licensees, the defendant requested that the original licenses be submitted for examination, and that was done. The defendant has made selections from the documents and from certain correspondence in connection with the documents, all of which were given freely to the defendant for examination. and have provided an abstract, and requests that the plaintiff put this abstract in evidence, and the plaintiff does so.

Abstract admitted, marked PLAINTIFF'S EXHIBIT No. 291.

MR. KREMER: That is introduced in view of the

P. 4726, after L. 3, insert " Re-d. Q. 15. Mr. Wilding, you used the same method "

great volume of contracts, and also in that connection I think it was suggested that a copy of your form of license, Mr. Williams, be introduced.

MR. WILLIAMS: We also offer a printed copy of the form of license of Minerals Separation, North American Corporation, the present standard form for licensees in the United States of America. And it may be added that this form of license is substantially the same as the earlier licenses granted by Minerals Separation Limited before Minerals Separation, North American Corporation assumed control.

The abstract contains the note, "old form" as referring to the old licenses of Minerals Separation Limited, and "new form" as applied to the form of license now offered in evidence.

It may be noted also that there were two forms of Minerals Separation licenses, and apparently that the line is drawn as to those two forms, rather than the new licenses of Minerals Separation, North American Corporation.

MR. KREMER: If they are all substantially the same, that is all I want.

MR. WILLIAMS: These statements, are made in lieu of evidence as to the forms, and for the purpose of simplifying and explaining what the defendant wishes to appear in explanation as to the licenses granted by the plaintiffs.

Form of license offered in evidence and admitted, marked PLAINTIFF'S EXHIBIT No. 292.

MR. WILLIAMS: I offer in evidence the Kirby mixing table "A" as exhibit 293.

Kirby mixing table admitted in evidence and marked PLAINTIFF'S EXHIBIT 293.

MR. WILLIAMS: I offer the Kirby separation tank "B" as plaintiff's exhibit 294.

Kirby separation tank "B" admitted in evidence and marked PLAINTIFF'S EXHIBIT 294.

MR. WILLIAMS: The gabbett is offered as complaintiff's exhibit 295.

Gabbett offered in evidence and marked PLAINTIFF'S EXHIBIT 295.

MR. WILLIAMS: The Cattermole upcast as complainant's exhibit 296.

Cattermole upcast admitted in evidence and marked PLAINTIFF'S EXHIBIT 296.

MR. WILLIAMS: The slide gabbett as complainant's exhibit 297.

Slide gabbett admitted in evidence and marked PLAINTIFF'S EXHIBIT 297.

MR. WILLIAMS: The bar mixer used by the plaintiff as plaintiff's exhibit 298.

Bar mixer admitted in evidence and marked PLAINTIFF'S EXHIBIT 298.

Arthur Howard Higgins.

MR. WILLIAMS: The batea as plaintiff's exhibit 299.

Batea admitted in evidence and marked PLAINTIFF'S EXHIBIT 299.

MR. WILLIAMS: Mr. Greninger was requested to produce a flow sheet of the Inspiration mill showing the three types of machines used in the sections of this mill.

MR. SCOTT: I don't think it will be necessary to examine Mr. Greninger. It seems very plain.

MR. WILLIAMS: It is offered in evidence as plaintiff's exhibit 300.

Flow sheet admitted in evidence and marked PLAINTIFF'S EXHIBIT 300.

MR. SCOTT: It is noted that the witness is offered for examination as to the details of the flow sheet and defendant's counsel does not care to examine him.

ARTHUR HOWARD HIGGINS, Recalled, testified as follows:

DIRECT EXAMINATION

BY MR. WILLIAMS:

Q. 1. Were you present during the taking of the testimony of Mr. Phillips and—of Mr. Phillips as to the photographs and did you attend the magic lantern exhibition in the evening session of the court?

A. I was present on both occasions.

Q. 2. What have you to say as to the character of illustration offered by such photographs of external appearances?

A. I have examined the photographs carefully both with the naked eye and under a lens and find that they do not show a characteristic picture at all and from my point of view I cannot see that they are of any use whatever.

Q. 3. Now, a few of these photographs taken of froths produced with California eucalyptus oil. Has such an oil been used in flotation?

A. Not to my knowledge. That variety of eucalyptus is the variety that is used in medicine and it is much too expensive to use for flotation work.

Q. 4. Now, are you familiar with an eucalyptus oil that has been used in flotation?

A. Yes, with the eucalyptus amagydalena which is extensively used in Australia, and is a very efficient frothing agent.

Q. 5. What kind of oils are these eucalyptus oils?

A. They are classed as essential oils.

Q. 6. And what is their quality as to solubility when used in flotation?

A. I have examined a great many of them and found that they contained both soluble frothing agents and insoluble frothing agents.

Q. 7. Now, the oil mixture which Mr. Phillips used —so-called—was 70 per cent crude fuel oil, 17 per cent Yaryan pine oil, 13 per cent kerosene. What part of that mixture, if any, was a frothing agent?

Arthur Howard Higgins.

A. The pine oil. That contains as I say, both the soluble and insoluble frothing agents.

Q. 8. And what kind of oil is pine oil?

A. An essential oil.

Q. 9. Then he performed some experiment with pine tar oil and two experiments with wood tar oil and expressed the opinion that the oils were about the same ~~all the about the same~~ although the labels were different; what have you to say as to oils thus designated, as to whether they contain soluble and insoluble frothing agents?

A. These oils contain both insoluble and soluble frothing agents.

Q. 10. The other oils used in these experiments were kerosene in the 25 per cent kerosene experiment and as to that you have already testified, and then there was a smelter fuel oil. Have you examined that oil for the purpose of determining what it contained as to soluble and insoluble frothing agents?

A. No, I have not.

Q. 11. When that oil is used alone in proportion of five per cent as it was there used, what would you expect to obtain?

A. On that class of ore I should expect to obtain some kind of a magma.

WHEREUPON an adjournment was taken until 2:00 P. M., May 14th, 1917.

Arthur Howard Higgins.

2 o'clock p. m., May 14, 1917.

Q. 12. Mr. Higgins, were you one of the parties that visited the Magna plant of the Utah Copper Company for the purpose of viewing the operations in behalf of the plaintiff during the course of this trial?

A. No, I was not.

Q. 13. Were you one of the parties that visited the Butte & Superior plant for a similar purpose during the course of this trial?

A. Yes. I was.

Q. 14. And what did you do at that plant on that occasion?

A. I made general observations as to the method of working, and noted what results were obtained, and spent a good deal of time following different launders and pipes through the mill.

Q. 15. Were you supplied with a flow sheet at the time of this inspection?

A. Yes, I was.

Q. 16. And was that the flow sheet that was put in evidence on the Saturday before?

A. Yes.

Q. 17. I show you defendant's exhibit No. 165; was it a copy of that flow sheet that you were supplied with at the time of your inspection?

A. Yes; it was a blue print of that drawing.

Q. 18. How about the flow sheet defendant's exhibit 222; did you see that or any copy of it at the time of your inspection?

Arthur Howard Higgins.

A. No; I think the first time I saw that was on Thursday.

Q. 19. When that was put in evidence?

A. Yes.

Q. 20. And were we supplied with copies of this flow sheet when it was put in evidence?

A. No; I did not see any copies of that flow sheet.

Q. 21. Did you discover at the time of your inspection of the plant what happened to the tailings from cleaner No. 2?

A. No, I did not. I spent a good deal of time following different pipes and launders about the plant, and I found them very intricate and very well mixed up; and I do not think I could thoroughly satisfy myself about every launder and pipe within a week.

Q. 22. What have you to say as to the practice of running to waste the tailings of a second cleaner containing about 8% of zinc?

A. That is a bad metallurgical practice, and undoubtedly shows that there is some grave reason for turning out values of that grade, probably due to the fact that they wished to get rid of some deleterious material at that point.

Q. 23. Did you observe the operations of the Janney machines of the type of Nos. 1, 2 and 3 of each pyramid machine?

A. Yes, I did.

Q. 24. And, in these Janney machines were the spitzkasten plain or provided auxiliary aerating arrangements?

A. No, those were the ordinary spitzkasten of the full width.

Q. 25. And then the spitzkasten Nos. 4, 5, 6, and 7 of each pyramid machine, did you observe in those spitzkasten any different operation?

A. Yes; those spitzkasten were narrowed down very considerably, and had the air boxes in that have been described.

Q. 26. And what was the function performed by those air boxes?

A. The functions were the discharge of air, which undoubtedly agitated the pulp in the spitz boxes, being of course additional to the agitation it had already had in the Janney machine in the agitation chamber.

Q. 27. Would you denominate that agitation by aeration?

A. Yes, I think that would be a good description.

Q. 28. And what took place in the agitating chamber; how would you describe that?

A. That is agitation by mechanical means.

Q. 29. How is the operation effected there?

A. By the production of a vortex, which is drawn down by the agitator and subsequently broken by the same agitator.

Q. 30. Would you call that aeration by agitation?

A. Yes, that is aeration by agitation.

Q. 31. Then down at the end of the plant they had what they called air cells; did you observe those air cells and their operation?

A. Yes, I did; I found those were what is com-

Arthur Howard Higgins.

monly known as Callow cells. There again air was discharged in streams through the pulp, causing agitation.

Q. 32. And what did you see on the surface of those air baskets?

A. Froth consisting of very large bubbles carrying some slimes, chiefly gangue slimes, and also some coarser mineral. The product from that operation was low grade.

Q. 33. And was that operation an operation in accordance with the patent in suit?

A. Yes, that discharge of streams of air through the pulp agitates the pulp and produces the froth.

Q. 34. And in the Janney machines, where there was first an agitating chamber and then a spitzkasten and an air chamber, was or was not the process there carried on that of the patent in suit?

A. In my opinion, that was the process.

Q. 35. Now, in the Janney machines wherein there was an agitation chamber and plain spitzkasten, what process was there carried on?

A. It was in my opinion the process of the patent in suit.

Q. 36. Now, take the operation as a whole, as you saw it at the Butte & Superior on the day of this inspection was or was not the process of the patent in suit being carried on there?

A. In my opinion it was, but in addition to that there was also the process of the solution patent. There was pine oil there which contains a soluble frothing

agent, and afterwards I saw Dr. McIlhiney remove some of this soluble material from the clear solution of the pulp.

MR. SCOTT: I move that the latter part of the answer be stricken out as absolutely irrelevant to any issue in this suit, whether the witness thinks the process of some other patent not involved was or was not being carried out.

THE COURT: Please read the question and answer.

(Question and answer read).

MR. WILLIAMS: May I say a word before your honor rules. This operation at the Butte & Superior examined by this witness was an operation resembling the operation of the Ray, the Chino and the Utah that were said to represent the prior art, all of them were characterized by the use of a soluble frothing agent, and the explanation of these operations lies in that fact. Now, the witness is explaining the phenomena that were exhibited to him by the defendant. Is the witness to be restrained from full explanation?

THE COURT: Well, I think he went away beyond the question. His answer is not responsive. He was asked if it was the process of the patent in suit and he says yes and now he adds considerable about some other patent, which was not necessary to qualify his answer as given. It seems to me it is not a qualification but it is a mere addition. As the question and answer stand all after the words "in my opinion it is" may be stricken.

Arthur Howard Higgins.

Q. 37. MR. WILLIAMS: Was there in the operation exhibited to you by the defendant the carrying out of any other process than the process of the patent in suit?

A. Yes, there was.

MR. SCOTT: I object to that question too because other processes are not involved in this suit and it seems to me it is entirely irrelevant and immaterial. They may be practicing one hundred processes there.

THE COURT: Well, to a certain extent, yes, as far as the mere issue is involved. It is a part in conjunction with the processes in suit so that it may be fully laid before the court, especially if we are to go up there and view these operations I think he ought to be allowed to state what he saw. The objection is overruled.

Q. 37½. MR. WILLIAMS: What other process was being carried out with the process of the patent in suit?

A. Pine oil was being added to the pulp in mixture of oils that were fed into the pulp at the discharge from the tube mill. Pine oil contains both soluble agents and insoluble agents, and in my opinion the use of pine oil would make the process both that of the patent in suit and the solution patent.

MR. SCOTT: I repeat my original objection on the same ground.

THE COURT: Yes, the objection will be overruled.

MR. SCOTT: Exception.

Arthur Howard Higgins.

Q. 38. MR. WILLIAMS: What frothing agents were present in the operations of the defendant, those exhibited to you?

A. Pine oil, both the insoluble pine oil and the soluble pine oil.

Q. 39. About the other oils that were used, fuel oil and kerosene?

A. In small quantities fuel oil and kerosene are useful in the process in the patent in suit, chiefly for the purpose of preventing the coarse mineral from falling out of the froth. Used over and above that quantity, they are inert and may even be harmful to the process.

Q. 40. What is the effect of the use of a soluble frothing agent in conjunction with these large quantities of such oils as kerosene and fuel oil?

A. The addition of a soluble frothing agent causes the detrimental effects of the inert oils such as kerosene and Jones oil and fuel oil, to be more or less overcome.

Q. 41. When employing soluble frothing agents do you or do you not obtain as stable a froth as when you employ oily frothing agents in the manner of the patent in suit?

A. If the ore treated happens to be moderately coarse, then the oily agent gives a very much more stable froth than the soluble frothing agent; but if the mineral is ground sufficiently fine there is very little difference in the stability of the two froths.

Q. 42. And what is the effect of adding a small

Arthur Howard Higgins.

quantity of these oils which you have characterized as inert to a soluble frothing agent?

A. That prevents the falling out of the coarse particles from the froth. Only a very small quantity is necessary for that purpose and above that quantity the oil remains inert until it gets in such large quantities that it becomes harmful to the process.

Q. 43. Did you find in these operations exhibited to you at the Butte & Superior any operations of the prior art, Everson, Kirby, Froment, or California Journal, or any other?

A. No, I did not. The fact that they were using the Janney machines, which were invented long after the patent in suit, makes it impossible for the processes of the prior art to be carried out in the Butte & Superior mill.

Q. 44. Was this process being carried out for the purpose of any of these prior art patents or disclosures?

A. Not in my opinion.

Q. 45. Did it affect the result of any of these prior art disclosures or patents?

A. No, it did not.

Q. 46. Now, there has been evidence in this case of other operations at the Arthur and Magna plants of the Utah Copper Company, at the Ray Consolidated and at the Chino. Did you hear the testimony in regard to those operations?

A. Yes, I did.

Arthur Howard Higgins.

Q. 47. Were these operations operations of the prior art?

A. Not in my opinion.

Q. 48. And why not?

A. The processes were not carried out in machines disclosed in the prior art or according to the disclosures of the prior art.

Q. 49. Have you ever obtained mineral froth by the use of kerosene alone?

A. No, I have not.

Q. 50. By what name is kerosene known in England?

A. Paraffin oil or simply paraffin.

Q. 51. You mentioned two especial instances wherein you had obtained a mineral froth with petroleum oils. What were those exceptional instances?

A. One of them was the use of the material known as petrol which is used for motor cars in England and the other was in the use of a heavy lubricating oil such as is used for valves, and known as cosmos oil.

Q. 52. And is petrol in England the equivalent of gasoline in America?

A. Yes, it is the trade equivalent. It is rather lighter.

Q. 53. Did you examine these oils at the time that you made these experiments, for the purpose of determining the purity?

A. No, I did not.

Q. 54. Now, as to the oil that is described in the California Journal of Technology, can you state

Arthur Howard Higgins.

whether or not that is a mineral frothing oil.

A. That is not; that is the Elmore oil; that is not a frothing oil.

Q. 55. When you carried out your experiment on Saturday, repeating the operations performed by Mr. Phillips with 25% of kerosene, did you supply a specimen of that kerosene to defendant's representatives?

A. I think that was done; I gave instructions for that to be done.

Q. 56. And was a larger specimen called for and supplied?

A. Yes.

Q. 57. Now, are you ready to perform an experiment with Butte & Superior ore received from the defendant during March, 1917?

A. Yes, I am.

Q. 58. Is this the experiment that you started to perform and did not finish?

A. Yes.

Q. 59. Can you explain why the other experiment failed, if that is the fact?

A. Yes, the fact is that it failed. During the operation I noticed there was a quantity of sulphuretted hydrogen evolved, and it is well known that in the agitation froth process sulphuretted hydrogen is very detrimental. The experiment had previously been successful three times in succession. I have repeated that since. The ore shows, in spite of the most thorough mixing, a very patchy nature; some samples evolving more sulphuretted hydrogen than others. In order to

Arthur Howard Higgins.

get over the difficulty of getting an unusual quantity of sulphuretted hydrogen in that manner, I shall add to the pulp some copper sulphate, which will destroy the sulphuretted hydrogen evolved.

Q. 60. Are there other methods than this of preventing the deleterious effect of sulphuretted hydrogen in the agitation froth process?

A. Yes; any of the well known heavy metals will precipitate it, or it can be destroyed by an oxidizing agent, such as a permanganate, or anything that will react with it, such as sulphur dioxide.

Q. 61. The operation of preventing it is what sort of an operation?

A. It is a chemical operation which is well known.

Q. 62. This copper sulphate that you will use came from where?

A. It is part of the sample that we took at the Butte & Superior plant on the 29th of April.

Q. 63. Please describe the experiment which you are about to perform.

A. 2000 c.c. of water at 40° C.; 500 grams of Butte & Superior ore crushed to 65 mesh, the sample being received during March, 1917; 5.8 c.c. of sulphuric acid, and 3.4 c.c. of copper sulphate solution. That will be agitated for one minute, to make sure that the copper sulphate has had a chance to destroy any sulphuretted hydrogen evolved; then we will add .55 c.c. of oleic acid and agitate again for about three minutes, the speed of the agitation being between 850 and 900 revolutions per minute.

Arthur Howard Higgins.

Q. 64. In what machine will you perform this experiment?

A. In the slide Gabbett machine.

(Machine run for a certain period.)

Q. 65. What have you to say as to the result of this three minute agitation?

A. I have already said that this ore is very patchy, and in spite of the most thorough mixing one can not predict what will happen to it. The corrective is easy to apply, but one can not tell how much it will require. The result there is, there is still a smell of sulphuretted hydrogen coming from the pulp.

Q. 66. Did you smell it at the conclusion of the operation to detect it?

A. Yes.

Q. 67. What do you propose to do?

A. I will put in some more copper sulphate solution, 3 c.c.

Q. 68. Of the copper sulphate solution?

A. Of the same copper sulphate solution.

(Machine run again for a period.)

THE WITNESS: I will put in some more copper sulphate.

Q. 69. What was the result when the agitation was stopped the second time?

A. About three eights to one half an inch of foam which was readily broken.

MR. SCOTT: In other words, commonly speaking, it wasn't of any use?

A. Not much.

Arthur Howard Higgins.

MR. KENYON: Plaintiff's counsel has made the interlineation in the supplemental bill, page 7, third line from the bottom after the word "disclaimer" of the words "as well as the invention or inventions of claims 1, 2, 3, 5, 6, 7 and 12 of said letters patent," also in the next line the letter "s" at the end of the word "continue" changing it to "continues" and the same has been initialed in the margin by the clerk.

MR. KREMER: The defendant, after amendment to the supplemental bill of complaint by counsel for the plaintiff, with permission of court, amends the answer to the supplemental bill of complaint in the following particulars: by inserting in line 17 of page 5 of said answer to the supplemental complaint after the word "disclaimer" the following "or has employed processes of concentrating powdered ore embodying and containing the alleged invention or inventions of claims 1, 2, 3, 5, 6, 7 or 12 or any or either of them or at all of said letters patent"; and after the word "continues" in said line the following: "or continues". These interlineations so made have been initialed as follows by the clerk: "G. W. S. by H. H. W. 5 line 14 line 17."

THE COURT: It will be permitted.

Q. 70. MR. WILLIAMS: What about the result of the third agitation for three minutes following the addition of copper sulphate?

A. It has improved the results slightly. I think if we had sufficient of this percipitant the result would be quite satisfactory. It is only a matter of

Arthur Howard Higgins.

time, adding that same material and continuing the agitation.

Q. 71. What about the temperature of the mixture?

A. The temperature has fallen to 35.

Q. 72. And you aimed to carry on the operation at what temperature?

A. At 40° C.

Q. 73. And it is now 35° C.?

A. It is now 35.

Q. 74. And you first agitated for three minutes and then after stopping you added three c.c. of copper sulphate and then you agitated for another three minutes and then stopped and added 3 c.c. more of copper sulphate, is that right?

A. Yes, that is right.

Q. 75. So that there were three periods of three minutes each agitation?

A. Yes.

Q. 76. And you say there has been a gradual improvement?

A. Each addition of copper sulphate has shown an improvement.

MR. SCOTT: May I ask Mr. Higgins how he would characterize this last float with regard to efficiency as to whether you have anything like a satisfactory recovery in that float there?

A. No, that is not a satisfactory recovery in it. Shall I continue with the copper sulphate.

Q. 77. MR. WILLIAMS: Now, would you pre-

fer to repeat this with the drop in temperature that you have or go on with another experiment with the ore that you received at an earlier date?

A. If we take a new lot of the same ore we have still got the same difficulty. We cannot predict what amount of copper sulphate that wants, although this sample has been very thoroughly mixed we don't seem to be able to get a representative mixture of the material and each sample that we take out requires a somewhat different quantity of copper sulphate. That is a condition I never have observed before in any of the samples I have handled.

Q. 78. I suggest that you carry on the experiment now with the older ore which you received from the Butte & Superior?

A. Yes, that can be done.

Q. 79. And what will you do with this one?

MR. SCOTT: That is a slide machine and I suggest that we slide it off and take samples for assay.

THE WITNESS: If you wish to do that, Mr. Scott, I think we will add some more copper sulphate.

Q. 80. THE COURT: How much oil per ton?

A. Two pounds of oleic acid per ton.

Q. 81. THE COURT: What is that percentage?

A. .1 per cent.

MR. WILLIAMS: Can you heat this mixture as it is in the vessel?

A. I can, yes.

Arthur Howard Higgins.

Q. 82. Suppose you do that and then go on with the other experiment.

MR. SHERIDAN: I would like to have your honor notice the overloading there.

THE WITNESS: I should like to make the remark that what Mr. Sheridan calls overloading is simply some of the mineral being dropped out of the froth falling down slightly through the flocculated slimes.

(Witness perfoms an experiment.)

Q. 83. MR. SCOTT: What temperature was the pulp raised to when you just tried it with the thermometer?

A. 39° C.

MR. WILLIAMS: What has been the result of heating the pulp, adding 3 c.c. of copper sulphate and repeating the three minute agitation?

A. There was about the same amount of froth floating on the surface but not sufficient to make any recoveries to speak of.

Q. 84. Now, describe the experiment that you are about to do.

A. I am about to take 500 gms. of Butte & Superior ore received by us in 1912 or 1913, 2000 c.c. of water, at about 40° C., 5.8 c.c. of sulphuric acid, and add to that .55 c.c. of oleic acid which is two pounds per ton and agitate three minutes at about 850 to 900 r. p. m.

Q. 85. What is the result of the operation that you have now carried on?

A. That operation is successful; there is about an inch and three-quarters of heavy mineralized froth on the surface.

Q. 86. What is your judgment as to whether or not that is a good recovery?

A. The tailings appear very clean; I think it is a good recovery.

Q. 87. BY MR. SCOTT: Do there appear to be any pendant masses at the bottom of the froth that you have just made?

A. The bottom of the froth is somewhat irregular.

Q. 88. BY MR. WILLIAMS: What is the significance of that irregularity?

A. I don't see that it has any significance whatever. It is probably due to the compression of the froth of its own weight since it rose to the surface of the pulp.

Q. 89. THE COURT: A little bit troubled interface?

A. Yes, it is an interface all right. In this case it is not an interface of oil and water; it is an interface of air and water.

Q. 90. BY MR. WILLIAMS: Do you usually succeed in getting froths without pendant parts with oleic acid?

A. No, they are usually a little bit like that. It shows more holes when the froth is heavily mineralized. When the froth contains less mineral it is usually much flatter. It comes flat on the upper sur-

Arthur Howard Higgins.

face and on the under surface, as it did in this one that failed.

Q. 91. Now, what do you propose to do with the result of this last experiment which has produced this froth that you have described?

A. I understand you wish me to add more oil to that.

Q. 92. What will be the result of adding more oil?

A. The froth will sink, and it will form granules.

Q. 93. How much more oil will you add?

A. 20 c.c., so that the total oil will be 3.7%.

(Machine run for a period.)

Q. 94. Now, describe the result of this last operation upon stopping the agitation.

A. A few granules came up to the surface, carried there by air bubbles, and on reaching the surface the air bubbles burst, leaving a few granules swimming on the surface, not enough to completely cover the water. A lot of the granules, on the bursting of the air bubbles, sank to the bottom, and a large number of granules can be seen on the bottom of the jar, through the window.

Q. 95. What kind of float is that on the surface, to the extent that it is there?

A. It is a skin float or surface tension float. These few minerals are swimming on top of the water just the same as a greased needle would swim there.

Q. 96. Is there any froth?

A. No, there is no froth.

Q. 97. Can you separate a few of those granules?

A. I would like to run the machine at a much higher speed, to show that the effect of high speed makes no difference in the formation of the granules.

Q. 98. What speed will you run it at?

A. I think we can get it up to 1500.

(Machine run for a period.)

Q. 99. Now, how long did you agitate it at this higher speed?

A. One minute and the result was just the same—that is some speed over 1500 revolutions per minute, but the result was just the same as at the lower speed. Now, I think we can run out some of the granules. (Removing granules from the Gabbett.) That shows both the granules and the sand.

Q. 100. How effective has the granulation been?

A. The granulation is very good, seems to have taken up practically the whole of the mineral.

Q. 101. Now, as to the first example with the recent ore of the Butte & Superior, what is your personal observation as to the condition of the material that you have used?

A. Gas is still being evolved from it.

MR. WILLIAMS: I think we will not take the time of the court further in this experiment, Mr. Higgins. The direct examination is closed.

Arthur Howard Higgins.

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 102. I think you said, Mr. Higgins, this morning that the photographs which were made by Mr. Phillips did not exhibit any of the characteristics, I think you said, of the froth present. Now, what are the characteristics that you have in mind?

A. The appearance of the froth in its composition. The color is also characteristic, the glistening of the mineral and so forth. I was unable to detect those from those photographs.

X-Q. 103. The glistening of the mineral, the color and what else?

A. Also the conformation of the bubbles.

X-Q. 104. Those are the things that define the difference between what you call an air froth and an oil froth?

A. No, I never said so.

X-Q. 105. Well, what difference does it make whether is is—whether these characteristics are shown or not if they don't have anything to do with the difference between the two floats you have defined? What are those characteristics that would tell us that difference?

A. The photographs do not show anything to me because as I say I cannot see these differences that I looked for.

X-Q. 106. You mean the three you have just named?

Arthur Howard Higgins.

A. Yes, the amount of oil and that kind of thing. If you are considering the differences between an air froth and a magma it is necessary not only to see the color and shape and form and that kind of thing, but also to know something about the oil—about the amount of oil it contains.

X-Q. 107. Does the ability of this float to carry a metalliferous mineral have any bearing upon whether it is what you call an air froth or a magma?

A. Referring to any kind of float?

X-Q. 108. Well, I am referring to the kind you have mentioned, the air froth as you call it, and the magma or oil froth?

A. The ability of an air froth to carry mineral depends entirely on the ~~ore.~~ air The oil is not responsible at all for the flotation of the mineral, as far as its buoyancy is concerned. The ability of a magma to carry mineral depends sometimes on the amount of oil and occasionally you can replace some of that by bubbles of gas of one kind or another so that in that case of course the air is not the efficient carrying agent although it may assist the magma in floating.

X-Q. 109. What is it, in what you call an air froth?

A. The carrying power or buoyancy does not come from the oil. Two pounds of oil to the ton of ore having a specific gravity of .9 would be able to float about two-tenths of a pound of mineral.

X-Q. 110. About two-tenths of a pound?

A. Yes.

Arthur Howard Higgins.

X-Q. 111. Well, suppose you had twenty pounds of oil, how much mineral would that be able to carry?

A. Twenty pounds per ton of ore, of course that would carry ten times as much, as far as buoyancy is concerned.

X-Q. 112. How much would that be? Two pounds?

A. Yes.

X-Q. 113. So that with twenty pounds of oil to the ton of ore you can only account for the flotation of two pounds by the buoyancy of the oil?

A. That is of course assuming that the whole of the oil goes to the mineral and floats upon the surface.

X-Q. 114. Giving the oil every possible credit for flotation?

A. Yes.

X-Q. 115. Which of course is rather overstating it?

A. Yes.

X-Q. 116. But even with twenty pounds of oil per ton of ore you cannot by any possibility, theoretically or otherwise, float more than two pounds of material?

A. As long as you refer only to the buoyancy of the oil, that is correct. If you use the oil in the same way, apply the efforts of a skin surface float, twenty pounds of oil to the ton would of course make you a totally different showing. You would not reduce the buoyancy of the oil.

X-Q. 117. Well, now, is the definition between

what you call an air froth and a magma or oil froth, does that reside in the relation between the buoyancy supplied or possibly supplied by the oil and that supplied by the air or other gas?

A. In part.

X-Q. 118. In part?

A. As I said before, some of the buoyancy may be due to the oil. You may enhance that buoyancy by entangling air in the mass.

X-Q. 119. I will ask you another question: Is the difference between what you call an air froth and an oil froth or magma a difference in the technical utility, having a difference in the amount of mineral that is recovered in an acceptable form, or does it reside in something entirely separate and apart from any consideration of utility but merely something within the realm of scientific observation?

A. My observation leads me to the opinion that a magma has a very different utility to an air froth. One can obtain a magma in a small vessel such as these measuring vessels, making it look very nice and apparently carrying large values, whereas when you come to separate these in a large scale, the viscosity is not sufficient to hold it over the surface it has to travel it over and you get very great losses. The scientific difference I don't know much about that.

X-Q. 120. Well, I don't know that I understand your answer. Do you mean that you think that the difference between the air froth and the oil froth

Arthur Howard Higgins.

or magma as we call them is a difference in their respective technical utilities?

A. It is not only a difference in their properties but in their technical utility as you suggest.

X-Q. 121. Well, how useful does a float have to be to be an air froth? Can't you give it in terms of recovery or efficiency? If that is what the difference is it ought to be something exact?

A. No, I haven't had any technical experience working with magma and I have got no figures to use by way of comparison. The magma floats I gave up long since as being quite useless although the use of a soluble frothing agent helps very considerably, to my mind they are not sufficiently valuable to spend any time working with them.

X-Q. 122. In other words you cannot define the difference upon the basis of utility? Is that what you mean to say?

A. If you take exactly the same condition you will find that as a rule when you get a magma you get a less useful result than when you get a froth, but I cannot compare one magma with another air froth. You might compare a fair magma with a froth of that nature, which is more or less useless (referring to a froth in one of the experiments recently performed).

X-Q. 123. Well, can't you state this in the quantity of reagents used? Can't you state it somehow?

A. The quantity of reagents does not decide the difference. It is a matter of process and results.

Arthur Howard Higgins.

X-Q. 124. So that by being told the quantity of reagents—and by "reagents" I mean the oil, speaking generically—by being told that you are not able to determine in advance whether you are going to have this so-called air froth or the oil froth?

A. Within certain limits. If I know the conditions that are going to be used, for instance if you tell me you were going to use 300 per cent of oil to the ton and you were going to roll it over, I could tell what kind of results you would get.

X-Q. 125. Suppose I would tell you I was going to use 2 per cent of oil?

A. Then I can't tell you because I don't know what conditions you are going to use it under or what the many large variants are that enter into the process, what kind of result it is going to ~~get~~ give.

X-Q. 126. Suppose I tell you I was using—I was going to use nine-tenths of a per cent of oil. Can you tell me then without knowing all of these things?

A. I can't tell you unless I know something about the condition and the way the process is carried out.

X-Q. 127. Then whether the amount of oil is less than one per cent or more than one per cent, it is impossible to tell whether you are going to get this air froth or not, without having additional facts or making an investigation?

A. In my opinion it is necessary to see the process and examine something of those conditions that make the difference in the results for the use of that percentage of oil.

Arthur Howard Higgins.

X-Q. 128. I think the question related to either over or under one per cent, did it not? If you are under a misapprehension I will state the question again.

A. I would like to state I was under the apprehension that you mentioned about .9 to 1.1 in your preceding question.

X-Q. 129. Yes, something either side, either over or under one per cent. You stated a while ago that the operations which you saw in the Butte & Superior mill could not be the processes of the article in the California Journal of Technology because the process was carried out in Janney machines which were not invented until some years after the article was written. Now, how is it that the process of the patent in suit can in your opinion be carried out in that machine when the machine was not invented until some years after the patent in suit was drafted and granted?

A. I believe that is a matter of law.

X-Q. 130. You mean it is a matter of law regarding the process of the patent in suit but not regarding the California Journal?

A. I believe that is a matter for the court to determine whether, a process can be carried out in a modern apparatus and still infringe the patent.

X-Q. 131. What I want to find out from you, do you know of any facts, technical, scientific or otherwise, that would prevent the process of the California Journal being carried out in Janney machines any more

than it would prevent the process of the patent in suit being carried out in Janney machines?

A. No, I know of no facts of any kind to prevent anyone from making an improvement on any patent.

X-Q. 132. Or on any publication, I suppose?

A. Or on any publication.

X-Q. 133. If you used a soluble frothing agent, purely soluble frothing agent, without any insoluble admixture, and otherwise follow the directions of the patent in suit, would you be practicing the process of the patent in suit?

A. In my opinion if you use a total or completely soluble agent you would not be using the process of the patent in suit.

X-Q. 134. Is there such a thing in your opinion as an insoluble frothing agent?

A. Yes.

X-Q. 135. What are some of them?

A. Oleic acid is one of them. That is the example given in the patent.

X-Q. 136. Have you seen the Janney machine in other places than in the Butte & Superior mill used for carrying on the process described in the patent in suit?

A. No, I have not.

X-Q. 137. Did you ever see the apparatus described in the patent in suit and illustrated there used in practice in this country?

A. No, not in this country or in practice.

Arthur Howard Higgins.

X-Q. 138. Where did you see it, if you have seen it?

A. The apparatus shown in the drawing?

X-Q. 139. In the patent in suit, including the cone Gabbett and the open launder for taking the pulp to a settling affair consisting of three pointed boxes?

A. That was in use in the laboratory in London.

X-Q. 140. Was it ever in use anywhere else?

A. Well, it was in use in Australia, except that the three boxes were separate and the pulp ran from one to the other. The same principle was adopted, though.

X-Q. 141. Is it in use anywhere in the world now to your knowledge?

A. Not to my knowledge. The necessity of having three spitz boxes has gone absolutely with the much finer crushing that is now used.

X-Q. 142. How lately to your knowledge was such an apparatus as that described in the patent in suit and illustrated therein used in operation for ordinary commercial purposes?

A. To my knowledge not since 1908.

X-Q. 143. And was the one you saw then just like the one described in the patent in suit?

A. No, it was the one that I spoke of in Australia, with the differences in respect to the three boxes being separate, instead of being joined.

X-Q. 144. It had an open launder, did it?

A. Yes, that had an open launder.

Arthur Howard Higgins.

X-Q. 145. You commented upon the experiment performed by Mr. Dosenbach in which he made a froth, then by means of slower agitation caused the metalliferous mineral to sink, and by more rapid agitation raised it as a froth, repeating that cycle several times. In your comment you said that the material which Mr. Dosenbach caused to sink and which he separated in an up-cast as described in the Cattermole patent, it—You said that the material did not consist of granules, that it consisted of what?

A. I think they were simply separate pieces of coarse material with the fine material stuck here and there over them, but they were in no sense granules. A granule is a nice rounded mass, quite compact, and this appears to me to be a totally different thing. The action that I showed here shows the difference in the properties of granules and these mineral agglomerates, if it is an agglomerate, and I am not sure about that, even; it shows that it has different properties.

X-Q. 146. This material which was brought together and sunk by Mr. Dosenbach's experiment consisted of separate particles brought together, did it not?

A. You mean brought together in a froth?

X-Q. 147. Well, in conglomerations.

A. If you mean by conglomeration, one particle stuck to another yes, but an agglomeration to my mind means more than two particles; it means several.

Arthur Howard Higgins.

X-Q. 148. You think there were just two particles in each one that Mr. Dosenbach formed?

A. I have not made a close enough examination to answer, but in my mind they were not granules.

X-Q. 149. You could see them, couldn't you, in the up-cast?

A. I saw a mass of stuff coming out of the bottom of the up-cast, yes.

X-Q. 150. And you know that all of those were not single individual particles, the same as they came from the grinding operation, don't you?

A. I examined them under the microscope, and each one of them showed perfectly sharp faces, with what appeared to be a little dust on the corners now and again.

X-Q. 151. What useful property has a granule with more particles in it—the larger granule—than these made by Mr. Dosenbach? Mr. Dosenbach's granules sank in the up-cast, didn't they?

A. They did, but they are not granules.

X-Q. 152. That is their value, isn't it, that they sink in the up-cast so you can separate them?

A. That is not the result of the Cattermole process, that was shown in court; that was not the Cattermole process that was shown, and before you can take a position where you can say they are granules, they must be different from what he showed. I think I pointed out, on repeating the experiment, where the granules were agitated under high speed, and a little

Arthur Howard Higgins.

higher than Mr. Dosenbach used, and yet they did not float any more than they did under the low speed.

X-Q. 153. How did you perform the Cattermole experiment in court?

A. I got Cattermole granules in a cone mixer and separated the material in an up-cast.

X-Q. 154. Wasn't that just exactly what Mr. Dosenbach did?

A. Mr. Dosenbach went through the same operations as far as I recall, but he did not get the same results.

X-Q. 155. He got the mineral separated, didn't he?

A. Well, you can separate mineral by separating it on a placque, but that is not the Cattermole process.

X-Q. 156. Did Mr. Dosenbach separate it in an up-cast?

A. Yes.

X-Q. 157. And that is what you did?

A. Yes.

X-Q. 158. Then what is the difference?

A. The difference was that I made granules and he did not.

X-Q. 159. You mean that you got a little larger agglomeration of mineral than he did?

A. I was giving an illustration of the Cattermole process, which I think was very successful; Mr. Dosenbach's operation was not the Cattermole process.

X-Q. 160. Then we will go back to the same sub-

Arthur Howard Higgins.

ject again. You think Mr. Dosenbach did not agglomerate the metalliferous mineral particles into aggregates, did he?

A. I did not say it was not aggregates: I said there was probably some agglomeration, but they were not granules.

X-Q. 161. What is the difference between what you call granules and these agglomerates which you saw Mr. Dosenbach make?

A. There is just as much difference as there is between a house, which is firmly built together of brick and mortar, and a loose pile of brick. The pile of brick represents an agglomerate, but when you build it into a wall firm and smooth, a nice rounded mass, then it becomes a granule.

X-Q. 162. You will admit, won't you, that the agglomerates that Mr. Dosenbach made were large enough and firm enough to sink in the up-cast, while the slime was carried over the top, don't you?

A. The mineral did sink at the time, but that depends a great deal on the difference in size between the mineral and the gangue. One could take such an amount of mineral of fair size, and put it in with sand —I am giving you an example now, I am not suggesting anything—and you could, by using those sizes, separate them in an up-cast, exactly the same as in that experiment. Unless we have a screen analysis which tells us the distribution of the metal and sand, it is quite impossible to say whether that was due to agglomeration of the mineral or not.

Arthur Howard Higgins.

X-Q. 163. You got a sample of what Mr. Dosenbach used in that experiment?

A. Yes.

X-Q. 164. You did not find anything to indicate that that could have been classified that way forming it into granules?

A. I have not examined it from that point of view; I did not know that you would want to know that.

X-Q. 165. Do you think, honestly, that that was a simple act of classification, independent of the Cattermole process, that was carried on by Mr. Dosenbach?

A. I say I honestly believe there were some agglomerations there, as far as some of the particles went; but as far as other particles went it was not an agglomeration, and it was not the Cattermole process.

X-Q. 166. How about the fact that upon greater agitation the mineral froth as a froth appeared, and under another kind of agitation it sunk with the same quantity ~~quality~~ of oil and mineral?

A. That was because the mineral was not agglomerated. He had not there sufficient oil to attach the mineral particles to each other to make nice granules, and the oil was not able to get at the mineral and attach itself to it.

X-Q. 167. The mineral was separated in an upcast, and under one kind of agitation it sunk, and under the other it was raised?

A. That was the peculiarity of the experiment.

Arthur Howard Higgins.

X-Q. 168. It shows what difference the difference in the agitation made, didn't it?

A. In that particular experiment, yes. When we go to work and make the froth, and afterwards run the agitator very gently, about 300 revolutions, that has the effect of centrifugal separation. You have taken out the air and the mineral could not do anything else than sink.

X-Q. 169. That is when you are agitating slowly?

A. Yes.

X-Q. 170. You get a violent centrifugal action when you agitate slowly, but you do not get it when you agitate more rapidly?

A. No; when you do it more rapidly you have the air coming through the pulp all the time in the form of small bubbles.

X-Q. 171. The air comes in faster than the centrifugal force can throw it out?

A. When it is going on high speed you get a fresh supply of air every time it turns it around.

X-Q. 172. And when you are going at low speed, what happens?

A. Then you do not; if you run it sufficiently slowly, you get no air at all.

X-Q. 173. I suppose at the low speed the centrifugal action throws the air off because the air is so much heavier than the mineral?

A. No; I don't think I suggested such a thing.

X-Q. 174. If I remember right, Mr. Higgins, you

said that you used 900 r. p. m. for the Cattermole process and the same speed, 900 r. p. m. for the process of the patent in suit. My recollection is correct, is it not?

A. Yes, that was about the speed that we used I think I said so.

X-Q. 175. You made no distinction as to revolutions per minute of the agitation between the two?

A. No. The patent says that they are carried on —the patent in suit is carried on in the same manner as—in the same agitators as in the processes previously mentioned, which are the two Cattermole processes.

X-Q. 176. Then it is hardly necessary for me to ask you whether you agree with Dr. Leibmann who was the expert witness in the Hyde case when he said: "I believe that 500 to 600 revolutions are quite sufficient for the Cattermole process, but I believe that at least 1200 r. p. m. are necessary for the process of the patent in suit in the same apparatus."

MR. WILLIAMS: I presume that in view of the fact that that evidence is in the record it may not be objectionable to endeavor to get it in again, but it does not seem to me that the question is quite a warranted question and I object to it.

THE COURT: Well I think you may ask the question. This witness has performed some experiments at various speeds and another expert for the same party has expressed his opinion that different

Arthur Howard Higgins.

speeds will serve or are necessary. Now, I think to arrive at this witness' opinion, he may ask the question. The objection will be overruled.

A. Without specifying exactly what the conditions were under which these processes were to be carried out, I do not agree with the statement as it stands. If you say that the Cattermole can be carried out at 500 or 600, I think that is quite true. It is also true that the Cattermole can be carried out at the higher speed. Further, it is quite true that the agitation froth process can be carried out at one or two thousand. It is likewise true it can be carried out at less. Now, if you compare two speeds under different conditions you may get exactly the same results; and the froth in one case—or you may get a froth in one case and get granules in another case.

X-Q. 177. At exactly the same speed?

A. Yes, at the same speed, but it may take some differences in other conditions, such as the time or the temperatures or the size of the granules, something of that kind. There are so many conditions that alter these facts that one cannot really give you a flat rate on that, you have to consider so many things at the same time.

X-Q. 178. You say that with the same amount of oil the different speeds might give you the different results, according to other conditions?

A. Oh, I hope I did not. I did not mean to say that.

(The witness' answer read as follows: "Without specifying exactly what the conditions were under

which these processes were to be carried out, I do not agree with the statement as it stands. If you say that the Cattermole can be carried out at 500 or 600, I think that is quite true. It is also true that the Cattermole can be carried out at the higher speed. Further, it is quite true that the agitation froth process can be carried out at one or two thousand. It is likewise true it can be carried out at less. Now, if you compare two speeds under different conditions you may get exactly the same results; and the froth in one case—or you may get a froth in one case and get granules in another case. X-Q. At exactly the same speed? A. Yes, at the same speed, but it may take some differences in other conditions, such as the time or the temperature or the size of the granules, something of that kind. There are so many conditions that alter these facts that one cannot really give you a flat rate on that, you have to consider so many things at the same time.")

X-Q. 179. And no one of these many things is guiding in itself, as to the result, is it?

A. Not absolutely, no. They all work together, one acting one way and another acting another way.

X-Q. 180. The final effect is a sort of a resultant of all these different forces that are at work, and conditions?

A. Yes, that is true. One cannot take the amount of oil or the fineness of grinding or the temperature or the time of agitation without considering each at the same time. An alteration of one may make an alteration of another. That is particularly true with the Cat-

Arthur Howard Higgins.

termole process; more so than of the agitation froth process.

X-Q. 181. When you performed that experiment with the Elm Orlu ore about which you testified in the Hyde case, using 3.6 per cent of cotton seed oil, I think it was?

A. Yes.

X-Q. 182. You obtained a float which you described as follows: "In about three minutes the plant had settled into a permanent condition. The float on the first spitzkasten was copious, being about one inch to an inch and a half deep and though oily in appearance, when closely examined, did not differ in appearance from the usual agitation froth at a distance of a few feet." Now, what is it aside from appearance, what is it—was it an air froth—was it an agitation froth as it was called at the time of the Hyde suit, now called an air froth, or was it one of these magmas that you spoke of or oil froths?

A. I think I went on and gave some further description.

X-Q. 183. I will read the rest: "These floats were exceedingly dense and occasionally fell down in large masses. The tailings contained some granules and did not indicate a satisfactory recovery." Then you give the assay.

A. As far as I remember that froth, it was chiefly floating granules entangled with air and the very fact that every now and then the froth would suddenly

Arthur Howard Higgins.

sweep in to a great vortex and tumble down and clea~~ned~~n almost the whole spitzkasten showed it had very different properties from an air froth. As to whether it was a magma or not I do not feel quite certain. I think that depends largely on the definition of magma. I think in my opinion I should say it was not exactly a magma but a collection of floating granules.

X-Q. 184. Well, how many of these kinds of flotation—of floats have we now? We have got a magma, an oil froth, an air froth, and what is this last one?

A. These floating granules.

X-Q. 185. Now, a floating granule an inch to an inch and a half deep, what makes them float?

A. Largely the entrapment of the air. You see if you spread it out on a large surface, for instance, such as Mr. Chapman did in London with the same quantity of oil, that was run out over a very much larger surface and then of course the air was given a chance to escape, which it did readily and left nothing floating worth speaking of. I believe the recovery in that case was something like eight or nine per cent. That floating is caused largely by the mechanical prevention of the escape of gas or air.

X-Q. 186. What do you mean by "the ~~M~~mechanical prevention"?

A. Well, it is something like enclosing it in a cork.

X-Q. 187. In a what?

Arthur Howard Higgins.

A. In a cork, bottling it up.

X-Q. 188. Well, what bottles it up?

A. The layer of granules on the top.

X-Q. 189. The granules enclose the air bubbles, you mean?

A. Yes.

X-Q. 190. Coat them?

A. No, entangle them.

X-Q. 191. There is a difference then between coating them and covering them?

A. Yes, there is a distinction there.

X-Q. 192. Let us have that difference so we will understand it?

A. Just the same distinction there is between the coating of air bubbles in the agitation froth process and what you may ~~mean~~ call the coating of the air bubbles in the magma. In one case it is an entirely different thing from another case. In the first case you have the attachment direct to the air and in the other case it is more or less coated because it cannot escape quick enough. In one case it is more or less permanent and in the other it is temporary.

X-Q. 193. Well, aren't you rather explaining this in terms of something else? I want to know what the difference between the coating an air bubble is, with mineral particles, and covering it. Now, you say one is like a magma and the other is like an air froth. I am trying to find out the difference between these two things. What is the difference between coating a bubble with mineral and covering it was a mineral, with-

out referring to these other things in definite terms?

A. The coating of course is a term well known to the art and it is applied to coating such as you get in the agitation froth processes where the air is directly attached to the mineral. You get what appears to be a little cell of metalliferous mineral bent round into a curved surface. Of course that might be called "covering" if you like to use that as a synonym, but that is not the same thing as taking an air bubble and pouring oil over the surface. For instance, you can take the agitation froth here and put a layer of grease over it but that would not be the same thing. That would be covering it with grease, but it would not be coating it.

X-Q. 194. Tell these things apart when you look at them, can you? If I have a series of them here made with oil running up from one-tenth by tenths up to three per cent, of oil, can you draw the line where one of these things leave off and the other begins?

A. I might and I might not.

X-Q. 195. Most likely not.

A. If I knew something about the ore and the way it behaved and the oil you put in I think I could tell you.

X-Q. .196. If you knew how much oil I used?

A. I should have to examine the conditions. As a result of the examination I think I could tell you where it went.

X-Q. 197. You never did such a thing, did you?

A. No, it isn't exactly a fair thing to ask a man to

Arthur Howard Higgins.

do because these graduations where one thing may occur at the same time as another would be very difficult to decide. Still I know of one test by which I might decide that matter.

X-Q. 198. You saw the large machine work upstairs, did you in the grand jury room, one of defendant's exhibits, having seven cells I think and three emulsifiers and a cleaner and a recleaner?

A. Yes, I was there.

X-Q. 199. What did that produce, an air froth with the bubbles coated or a magma with—or a magma or oil froth with the bubbles coated?

A. In my opinion that was an air froth.

X-Q. 200. You think that was the agitation froth or the air froth of the patent in suit?

A. In my opinion that was the process of the patent in suit and the result of the patent in suit.

X-Q. 201. You know how much oil was used?

A. Yes.

X-Q. 202. What is your recollection of it?

A. 36 pounds to the ton.

X-Q. 203. 36?

A. I think it was 36, wasn't it?

X-Q. 204. 42 pounds is what the evidence shows was used.

A. Yes.

X-Q. 205. That is 2.1 per cent, is it not?

A. Yes.

X-Q. 206. What does the patent in suit recommend? From two one-hundredths to five-tenths, doesn't it?

Arthur Howard Higgins.

A. I think it ~~recognizes~~ recommends that quantity. Of course in the case of that working of the plant upstairs there was a waste of oil on the gangue. The slimes took a great deal of oil. There was also an inert oil there which was probably not attached to anything, just wandering about the surface in an emulsion.

X-Q. 207. But didn't interfere with the process going on, did it?

A. Not altogether. I think it materially impaired the results you would have got if you had used the recommendation of the patent in suit.

X-Q. 208. I think you referred the other day to some experiment that had been performed by a witness in the Hyde case in which experiment the concentrate was purer than the tailing. What experiment was that you referred to?

A. I think that was in connection with Everson patent. I think I did that experiment myself for Dr. Chandler.

X-Q. 209. You were an employe of the Minerals Separation, weren't you?

A. I was.

X-Q. 210. And you are still?

A. I am.

X-Q. 211. Dr. Chandler was their expert witness wasn't he?

A. Yes, he was.

X-Q. 212. Did you ever see a demonstration of any patent fail besides the Everson patent, which you made to fail on that occasion?

Arthur Howard Higgins.

A. I don't think I intentionally made that fail. I had certain instructions from Dr. Chandler and the fact that they did not turn out as the patent stated was not intentional on my part. I don't think that I should be accused of that.

X-Q. 213. I did not intend to put it that way, I apologize, and I will ask you if you ever saw an attempted demonstration of any other patent than this one, fail.

A. I saw one here this afternoon that I did myself.

X-Q. 214. I don't know that you described the battea very clearly in your testimony.

A. A batea is a dish, hollowed out in the center somewhat conical; the instrument may be made of wood or sheet iron; it is not very deep; I suppose the pit of the hollow will be about two and a half or three inches below the edge of the pan or dish.

X-Q. 215. The center is concave to the extent of two or three inches, you say?

A. Yes.

X-Q. 216. How do you describe the float produced as the result of the Froment process; I think you called it a magma or oil froth?

A. Yes, I should call that a magma, distended, of course, by gas bubbles.

X-Q. 217. You are not at all in agreement with the statements contained in the two British patents referred to by Dr. Sadtler, of which Minerals Separation is grantee and in which the Froment process

Arthur Howard Higgins.

is referred to as a means of forming mineral-bearing froth. You do not agree with that statement evidently?

MR. WILLIAMS: I think it would be well to present the statement to the witness rather than ask him to agree with things which may not be just as you state them.

MR. SCOTT: I will hand the witness the copies of the testimony and he can look for himself.

X-Q. 218. It occurs several times in the first one I hand you, and if you will hand me your book I will find you the other patent. I think that will do for a sample of what is in this one.

A. The first quotation did not make any difference at all between these froths, and did not say so.

X-Q. 219. I call your attention to the one in patent No. 7803 of 1905. I will ask you if that is not the British patent corresponding to the patent here in suit.

A. Yes, I think that is true. I should not say those are exactly the same nature. It seems to me they were made by different processes and I cannot understand how they could be.

X-Q. 220. MR. WILLIAMS: That refers to patent No. 23820 of 1910.

THE WITNESS: As to No. 10929 of 1910, those froths are not the same in my opinion, but it appears to me to be very feasible that magma could be blown up by the process that is described there. It might be suitable for that apparatus to be used in one of these

Arthur Howard Higgins.

results that are mentioned, but in my opinion they are not the same result.

X-Q. 221. How long have you been an employe of Minerals Separation and its predecessors in interest?

A. Well, in 1903 I was in the employ of Sulman and Picard nominally, but I believe really in the employ of Minerals Separation, though I do not know just what the title was at that time.

X-Q. 222. Are you a stockholder in Minerals Separation?

A. No, I am not.

X-Q. 223. Are you a stockholder in any of the companies allied with Minerals Separation Limited, the American corporation or any of these others?

A. No, I am not, although I hope to be some day.

X-Q. 224. Have you any contract or agreement contingent upon any occurrences that it will be possible for you to become a stockholder?

A. No.

X-Q. 225. Did you, in your testimony the other day, tell us the speed of the revolutions of the machine in which you first tried to demonstrate the process of the patent in suit, and failed?

A. Yes, I think it was about 850. We attempted to keep it at 850, but at first it stuck a little, and I think we remedied that.

X-Q. 226. You mean that the apparatus did not operate—did not rotate as rapidly as it should, and you think that you finally did get it to go at 850?

Arthur Howard Higgins.

A. When we made the test I think it was going at 850, yes.

X-Q. 227. That was the first attempt to demonstrate the patent in suit, made, I think, last Friday?

A. Yes, Friday.

X-Q. 228. At what speed did you rotate the apparatus in your first attempt here today, to demonstrate the application of the process of the patent in suit to the Butte & Superior ore?

A. It was the same speed, as far as we could get it, 850.

X-Q. 229. The speed was taken, was it?

A. Yes, they took the speed with a speedometer.

X-Q. 230. I wish you would ascertain with precision just what speed was taken today.

A. I have not got the exact figure. You see we can not take it when the machine is charged with pulp, but my assistants give the figure at about 900 to 950.

X-Q. 231. That would be the range in the various attempts you made today; that would be the range of speed in all the different intervals of agitation?

A. Yes; it may have gone down to 800 and then up to 950. There was a little variation in speed due to removing the heater off the circuit; that altered the rate considerably.

X-Q. 232. You are now referring exclusively to the first demonstration in which you had four periods of rotation in the attempt to get the froth?

A. Yes.

Arthur Howard Higgins.

X-Q. 233. Then after that, in a different machine, you made another attempt to demonstrate the process of the patent in suit and obtained a froth which I think you said was about an inch and three-quarters thick?

A. Yes.

X-Q. 234. What was the speed of the rotation in that later and more successful demonstration?

A. We set that very carefully for a variation of 850 to 900. I think it went a little over 900; perhaps 950.

X-Q. 235. Can you find out how much?

A. That is as near as I can get it from the information I have.

~~X-Q. 236.~~ The motors are not very satisfactory, or it is the current probably. The power line, probably, the elevator runs on the same circuit, and every time the elevator is used you get a slight variation. I think those limits I have given you are near enough; it could be run a little lower or a little higher without materially altering the results.

RE-DIRECT EXAMINATION,

BY MR. WILLIAMS:

R-Q. 237. Now, Mr. Higgins, will you observe the froth that you obtained in the experiment you performed first this afternoon and tell me what its present condition is, and what that condition indicates?

A. It has risen up in the center about half an inch; it looks like dough set down before a fire. That condition could only be due to gas liberated from the ore ~~to~~ settled at the bottom of the vessel.

R-Q. 238. Suppose you met with such a condition as that in the laboratory, what would you do?

A. It would not take very long to destroy that gas; there are several ways of doing it. I recognize that the chief constituent in the case is sulphuretted hydrogen. There is also some smell of phosphi~~tes~~de to me.

R.-Q. 239. What would happen when you got rid of that gas, with that ore?

A. Then it goes very satisfactorily.

R-Q. 240. Now, in this model plant of the defendant which was operated in the grand jury room, do you remember what oil was used?

A. It was a mixture of a heavy petroleum, such as residuum, with kerosene and pine oils. I think the proportions were 70 of the fuel oil or residue, 12 of the kerosene and 18 of the pine.

R-Q. 241. Have you anything to add to what you said as to that operation? You said that that operation carried on the process of the patent in suit?

A. I could also say that it was carried on with, in my opinion, the process of the solution patent.

R-Q. 242. In the portion of your testimony in the Hyde suit describing what you did in a small plant with Elm Orlu ore, I will read on from where Mr.

Arthur Howard Higgins.

Scott read the testimony to you: "Samples were taken of these products and assayed," and then follows the assays, and then: "giving a recovery of 50% of zinc in the concentrates." Now, where was the other 50% of zinc, and in what condition?

A. The remainder of the zinc was in the tailings, as Cattermole granules.

R-Q. 243. If you had wished to carry on the process of concentration so as to improve the recovery, what would have been the next operation?

A. The separation of the granules from the tailings in the manner in which Cattermole describes.

what is the general relation in the specific gravity between the mineral and the gangue?

R-Q. 244. Now in the case of the Black Rock ore.

A. I think zinc sulphide is about four and a half, and the gangue is about one and a half.

R-Q. 245. Were there any difficulties there in regard to separating the mineral in an up-cast or by gravity?

A. Yes; that could not be satisfactorily done without some preliminary process such as sizing.

R-Q. 246. Now, in this operation that Mr. Dosenbach carried on, was the use of an up-cast and the separation in the up-cast a criterion as to the presence of the Cattermole process?

A. No, it was not.

R-Q. 247. You were asked, when you spoke of an Australian plant wherein there were spitzkasten with aprons. I will show you a drawing in the Hyde

record, marked "Australian Model Plant" appearing on page 1021 thereof. Is that a representation of the plant to which you refer?

A. No, that is not the same plant; that is not the one I was referring to. In the one I referred to with the apron, the apron was much narrower than in this particular plant and extended for a longer distance. It was the plant at work in the Central Mine in Australia.

R-Q. 248. And this drawing showing spitzkasten with aprons gives the general illustration, does it or not, of the apron idea?

A. Yes; the principle is the same.

R-Q. 249. Now, what characteristics has the Janney machine as to agitation which resembles or differs from the prior art agitation?

A. The agitation is very much more violent, and that has the result of making innumerable more bubbles and very much smaller bubbles.

R-Q. 250. What was the amount of oil that streamed into the separating tank in the Kirby experiment that you carried on in court?

A. That was approximately 230 grams.

R-Q. 251. And that was what percentage of the ore?

A. 5.75%.

WITNESS EXCUSED.

MR. WILLIAMS: It is noted that Mr. Chapman was requested to present a screen analysis of the feed

to flotation machines at the Anaconda plant, and he has now produced it, and it is offered to counsel for defendant, and I offer it in evidence, or it may be copied into the record.

MR. SCOTT: Let it be copied into the record.

"SCREEN SIZING TEST ON DORR CLASSIFIER OVERFLOW, OR FEED TO FLOTATION MACHINE.

Screen Size Square Mesh	Aperture, Mm. Square	Cumulative Per Cent. Solids
+ 16	1.180	0.3
+ 2~~5~~ 4	0.730	1.3
+ 40	0.430	3.0
+ 60	0.260	5.8
+ 80	0.210	12.8
+110	0.130	38.5
+130	0.110	42.3
+160	0.085	54.8
+200	0.076	59.3
+240	0.063	62.8
—240	0.063	37.2"

MR. WILLIAMS: Mr. Chapman was also asked to furnish a flow sheet of the Braden Copper Company plant, including the flotation plant, and this flow sheet is now produced and offered in evidence and marked Plaintiff's Exhibit No. 301.

Flow sheet admitted in evidence marked PLAINTIFF'S EXHIBIT No. 301.

George A. Chapman.

GEORGE A. CHAPMAN, a witness for plaintiff, recalled for cross examination, testified as follows:

CROSS EXAMINATION,

BY MR. SCOTT:

X-Q. 2. You have indicated the oil feed and the acid feed on this flotation sheet, exhibit 301. I will ask you what kind of oil is used at Braden?

A. A mixture of Swedish wood tar oil, the same as is used for sheep dipping in South America, and American fuel oil.

X-Q. 3. Texas fuel oil?

A. Texas, chiefly.

X-Q. 4. You may have testified to that before, but I was not sure.

A. Yes, it is in the record.

WITNESS EXCUSED.

MR. WILLIAMS: Save for the fact that we have a few assays that are not quite ready, and that I wish to offer in evidence photographic copies of the pages of Ure's Dictionary which were referred to by Mr. Higgins, and that there was some material to be furnished by Mr. Wiggin, who happens not to be in court today, plaintiff's case is closed.

MR. SCOTT: I would like to examine two or three witnesses on sur-rebuttal on points that have arisen in the course of the rebuttal testimony. The first will be Dr. Sadtler.

MR. WILLIAMS: If your honor please, would it not be well for us to know whether or not these are new points that have arisen; because if they are not we will object to them.

THE COURT: We will know better when we hear the questions. I suppose we can assume, and possibly should assume that that is their intention. He says it is sur-rebuttal, and we can not tell until he asks the questions.

MR. WILLIAMS: I thought it might possibly simplify matters if counsel will state what he expects to prove, and then your honor can decide upon it.

THE COURT: You may call your witness.

DR. SAMUEL P. SADTLER, recalled on behalf of defendant in sur-rebuttal testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Have you made any investigation, Dr. Sadtler, regarding the possibility of the kerosene used by Mr. Dosenbach containing a soluble ingredient, and if so, whether such soluble ingredients, if present has any effect?

A. I have carried out examinations—

Q. 2. MR. GARRISON: Your honor, I think we should be entitled to a yes or no answer; so that we can understand the trend of this testimony.

Samuel P. Sadtler

A. I have made investigations of kerosene samples referred to in connection with the testimony here. The one sample which was used, I believe, in an experiment by Mr. Phillips, and I analyzed that kerosene and some other.

Q. 3. Will you please describe the nature of your investigations?

A. I analyzed several samples of kerosene with particular reference to ascertaining as to what amount of foreign matter they contained, and what is soluble. The general outline of the method is as follows: 500 c.c. of kerosene sample are shaken up thoroughly with 500 c.c. of distilled water—shaken up so that the whole mixture was thoroughly broken up into fine bubbles throughout, and thoroughly intermingled, then allowed to settle and separate again in layers. Most of the kerosene layer was then poured off, and then the water was filtered through a wetted filter, a filter which had been wetted, so as to hold back any minute particles of oil. Now, having this watery filtrate, 100 c.c. of this filtrate was shaken up with pure chloroform. The chloroform was specially tested and found to be absolutely free from any impurities and to evaporate without residue and without any odor that was foreign at all to the chloroform. The chloroform was then run into a tared porcelain crucible and evaporated at a gentle heat on a warm plate. Then the odor of the residue, if any, was noticed, and the residue was weighed up. Similarly, 100 c.c. of the

filtrate was evaporated direct in a small beaker on a warm plate, to note the character of the residue and the odor, if any. I also determined the specific gravity of this watery distillate that was obtained from the shaking up of the kerosene and the filtering, so as to compare it with specific gravity of the distilled water taken at the same temperature and in the same specific gravity bottle, under exactly parallel conditions. I also tested the original kerosene sample with a dilute aqueous solution of methyl orange, as an indicator of free acid. I also tested the original kerosene sample with phenol-phthalein as an indicator of free alkali. This series of tests were applied to a number of kerosene samples. I will give first the results gotten with an average purchased water white kerosene, purchased from a grocery store here in Butte, and which I expected to take as a standard, because of its supposed purity. The chloroform residue—

MR. GARRISON: Your honor, I don't see how this is proper sur-rebuttal in any sense, a matter that this gentleman ascertained from some kerosene that he purchased in Butte. That can not be material in this case.

A. (Continued.) I will leave that be and take up another. I will take next kerosene "A"; that was a sample, as I understand, corresponding to what was used in the court experiment, and a sample of that was taken from a drum on the 16th day of April, 1917 at the same time as that which was drawn and brought and used here in court. The person who took it from

Samuel P. Sadtler

the dru~~g~~ on has given me his data, and he is here in court. The specific gravity of the sample of kerosene "A" which was used, and which was furnished also to the plaintiff at that time, and I believe it is the same sample concerning which Dr. McIlhiney has testified, the same kerosene about which we have testimony here —the specific gravity of that sample was .820. The chloroform residue gotten as described a moment ago from 100 c.c. of this sample corresponding to 100 c.c. of the oil—originally, of course, I took 500 c.c. of the oil and 500 c.c of water. Taking 100 c.c. of filtrate, corresponding to 100 c.c. of the oil, the chloroform residue was .0098 grams, which gave a slight woody odor. Now, 100 c.c. of the oil of .820 specific gravity, would weigh~~t~~ 82 grams. The residue was therefore .012 of 1%, reckoned on the oil. This was the amount of material which has been withdrawn by the distilled water and after-extracted from the distilled water by the chloroform and left on the gradual evaporation of the chloroform.

The residue from 100 c.c. evaporated on the hot plate by direct evaporation was a slight film, but I recognize the same slight woody odor faintly distinct, as it came down too. The film was an unweighable amount. The specific gravity of the water filtrate in this case was found to be exactly that of pure distilled water taken under the same conditions in the same apparatus and at the same temperature. The sample was also found to be free from acid by the test before referred to and free from alkali. I carried out again

Samuel P. Sadtler

an experiment on kerosene "A" after it had been thoroughly washed. The procedure was as follows: Kerosene "A" which has just been reported upon was first washed with an excess of distilled water by agitation in the square glass jar as shown here in court, and by the use of the agitating blades, using distilled water only. After allowing a sufficient time for separation and the whole mass was made thoroughly milky in this complete agitation in the square jar—after allowing sufficient time for separation I then took of the washed oil, the upper layer, 250 c.c. and I shook that up thoroughly again with 250 c.c. of distilled water in a litre flask, and then filtered through a wetted filter as before. I put this through the same form of analysis or tests as before described. The chloroform residue from 100 c.c. of this water filtered corresponds to 100 c.c. of the oil, therefore was .0006 gms. with no foreign odor, just the faint odor of kerosene oil. And 100 c.c. of the oil—this oil after the double washing, the gravity was taken, was 0.8112 —100 c.c. of this oil of that gravity would weigh 81.12 gms. The residue was then therefore .0007%, or in other words, seven ten-thousandths of one per cent reckoned on oil. That residue was undoubtedly a slight trace of the petroleum which could not be kept out of the watery filter, and as the odor indicated at the end of the chloroform operation was what was there and was weighed up. There was no other odor than that of the kerosene, a slight trace of the kerosene odor. The residue on evaporation of 50 c.c. on

a warm plate was practically nothing, no odor whatsoever. The sample was also found of course to be free from acid and free from alkali. Now, a larger quantity, relatively much larger sample of this double washed sample "A" has been obtained by the method of washing with distilled water and then agitated and I will be ready when the apparatus is here to carry out frothing tests with that double washed kerosene.

Q. 4. For the purpose of showing what?

A. For the purpose of showing that this kerosene absolutely free from any foreign material, did not lose its value as a frothing agent.

Q. 5. Then, doctor, did you also as an experiment—

A. Perhaps I better say a word about the frothing of kerosene.

Q. 6. You may proceed.

A. I have had experience in the past with the frothing of kerosene or kerosene supposed to produce a mineral froth, and I do not agree with the unqualified statement that kerosene is not a frothing oil. Some kerosenes that I have tried cannot be made to raise a froth with the flowing ore pulp. Other kerosenes do. In tests and experiments made several years ago, I tested Pennsylvania kerosene, California kerosene, Oklahoma kerosene, and Texas kerosene, and in three cases out of four I was able to produce excellent mineral froths with kerosenes. With

Samuel P. Sadtler

some of them I did not obtain any results. So I am of the opinion that many kerosenes, absolutely free from any foreign mixture—and I should say that one of these California oils that I mentioned, California kerosenes, I made myself in my laboratory direct from the California crude oil by distillation of the kerosene fraction, the treatment of the same with acid and steam stilling to clear it of light vapors, so that I had a standard kerosene fraction made from California petroleum that I could vouch for as being the genuine kerosene fraction of that crude oil. That kerosene is a good frothing agent, gave me excellent mineral froths. These results were gotten in June, 1914. I analyzed other kerosenes by this same method that I have just described for kerosene "A," but they were not samples that have been here in court.

MR. SCOTT: We will have time to do that experiment before five o'clock.

MR. GARRISON: We are going to object to doing this experiment.

THE WITNESS: Mr. Hackwood is the man to do it for me.

MR. GARRISON: The basis of our objection is this, that it is not sur-rebuttal. They did what they choose to do and we made our comments and their witnesses commented upon our comments, and I cannot see under what theory they can do some experiment which of course would be met by counter experiments ad infinitum.

THE COURT: What is it you are going to offer?

MR. SCOTT: The experiment is intended simply to illustrate what the doctor testified to, namely, that the frothing power of this kerosene is not due to the presence in it of any foreign substance or any soluble substance such as implied at least—not directly stated by the witness who testified for the plaintiff. Now, the doctor has testified to the investigations he has made, to the fact that he has removed the soluble ingredients, the very minute quantities of such ingredients, and the experiment is intended to show that after such treatment, absolutely removing all of these things, the oil acts precisely as we represented it to act in presenting our principal case.

MR. GARRISON: Now, if your honor pleases, they produce an experiment during the course of their case and the witnesses have said what they had to say about it and your honor had the benefit of visual observation of that experiment. Our witnesses then said what they had to say concerning the same. They have now gotten Dr. Sadtler to come back on the stand and say what he had to say as to what our witnesses said.

MR. SHERIDAN: No, it is not quite that.

MR. GARRISON: Permit me to finish, and then you may answer. Now, the doctor proposes that he—at least Mr. Scott now proffers the doing of another experiment with some preparation made by Dr. Sadtler from what they say was the oil that was used

in the first experiment. It simply is the opening of the door to infinite repetition by each of us of everything that is now in the case. The case now rests upon the testimony of these witnesses, plus what your honor has seen, and I cannot conceive under what theory they are now going to repeat experiments that have already been performed. They have already presented their experiments, which along with Dr. Sadtler's testimony, presents their side of the case. Our testimony then simply presents our side of the case and it seems to me if your honor pleases, there ought to be an end of the meeting of the issues. and that we have reached that end. If we go on in this way there is literally no end.

We will then produce experiments and analyses to disprove what Dr. Sadtler did, and then they will have somebody else come and without question they will do some other experiments, and it does seem to me that this is the place to meet that and to have a perfectly plain understanding that sur-rebuttal certainly does not mean anything more than meeting the new point that was raised, and the only point that we raised respecting that material was that our analysis showed a certain thing, and then this gentleman comes on the stand and says: "I made an analysis and it does not show the same thing." There is the issue that lies before your honor.

MR. SCOTT: This is not a matter of contradicting facts. I don't know that I would say that this

evidence that Dr. Sadtler is about to give contradicts anything whatever that Dr. McIlhiney said, but he is meeting the inference and the direct statement I think of Dr. McIlhiney that the reason that a certain experiment eventuated in a certain manner was because there was something in this oil besides the kerosene which we represented to be showing to the court. Now, Dr. Sadtler has found out that there was a trace—a minute trace of some soluble substance in there, and I propose to show that it makes no difference whether it is there or not, that this kerosene works in the same way; and in view of the character of the criticism offered it seems to me this is an instance where it is within strict propriety to present sur-rebuttal testimony.

THE COURT: They say you can do anything with figures and the court is beginning to wonder if it isn't true of experiments as well.

MR. GARRISON: The statement Mr. Scott has just made, it seems to me, illustrates the impropriety of this evidence. They have produced an experiment. Now, if they concede that in that experiment they utilized something else than a properly refined kerosene, that argues them out of court, they haven't a right to come here certainly and use a material that is not what they represent it to be, and then upon being detected correct the previous position that they took. So, of course, that is out of the question. Now, they came here and used this particualr material. We say that particular material upon analysis pro-

duced the following results—that is the result of the analysis of this material, from which we will argue whatever we think is proper from that. They produce this gentleman and he shows his analysis, from which they will argue whatever they think is proper from that. Now, in what view of the matter are they to repeat the experiment? I cannot see that this has any place in the sur-rebuttal case. If the amount of material that was found in there is arguable in Mr. Scott's behalf, he has got the benefit of that. Now, if it is arguable in our behalf, we have got the benefit of that. And what have we now that permits them to re-do the experiment? That is all they are going to do. If it is a new experiment, of course it has no place here at all.

MR. SCOTT: We have shown the amount of this soluble substance, which we do not admit is not a part of kerosene, kerosene purchased on the market. Dr. Sadtler has investigated its physical properties. He has not stated that it contains anything that is not proper in kerosene. But, having stated that, we wish to repel the unfair implication put forth that plaintiff's witnesses found the soluble substances in there and leaving the stand with a slurring implication that it was by reason of that soluble substance that the demonstration was a success. But he didn't go farther and prove it. He merely left it as a slur, and I think it is proper that we be permitted in sur-rebuttal to show that with the elimination of this minute, almost my-

Samuel P. Sadtler

thical ingredient, the demonstration operates in precisely the same way.

MR. GARRISON: See what that means! We have got to take this and analyze it and we have got to try our experiment with it and we have to come in and do these experiments. If that is sur-rebuttal, then I don't understand what sur-rebuttal is. That means going over and over the original issues in this case as long as your honor can possibly, physically, sit on the bench. They have had the benefit of Dr. Sadtler's analysis. The new matter we brought in was a matter of analysis. We said that in our analysis we found so and so. This was our analysis. We have brought that in here. If it is an old experiment on what ground do they do it? If it is a new experiment Mr. Scott is not ingenious enough to suggest why they should do it.

MR. SCOTT: If your testimony was not intended to create the impression in the mind of the court that it was by reason of some foreign substance that this demontsration was a success, then the testimony is not properly in the case, and if you admit it was not intended for that purpose I move that it be stricken out.

THE COURT: We will see what we can do with this in the morning. It is now five o'clock and we will adjourn until tomorrow morning.

WHEREUPON an adjournment was taken until 10:00 A. M., Tuesday, May 15th, 1917.

Tuesday, May 15, 1917, 10:00 A. M.

THE COURT: In reference to the matter before the court on the objection:

In this case, the plaintiff, the actor comes and introduces its evidence in chief to support its patent, including the patent; and thereupon the defendant introduces its evidence in defense, as to all the defenses that it has incorporated in its answer, and amongst other things, it presented to the court certain experiments as experiments with kerosene, to show what could be done with kerosene oil under certain circumstances. This kerosene, it seems, was of its own oils, and samples were given to the plaintiff at the time the experiments were performed. At that time or at some time during the defendant's case in chief, it developed that this kerosene might be open to question; it developed from the defendant's own evidence that it had been so contained in vessels that there might be room for a claim that it was mixed to some extent—contaminated we might say with other oils. Now, it was open to the defendant, if it wanted to show the court a kerosene experiment, of course, to satisfy the court of the integrity of its experiment, and of all of its experiments; even as the burden rests on the plaintiff to satisfy the court of the integrity of its experiments. The defendant, however, allowed the matter to stand as it was, and closed its case. Then the plaintiff proceeded to introduce rebuttal evidence; that was the first step in the case in which rebuttal evidence appeared, and the actor prepared to meet the case pre-

sented by the defendant. Rebuttal evidence is such evidence as tends to antagonize or refute the facts brought out by the other party. Rebuttal evidence is never merely reasserting evidence which was introduced in chief, and it is not merely going over his case again by cumulative evidence, reaffirming what was in his case in chief; but it is to meet anything new that has appeared in the other party's case that is not a mere contradiction of the first party's case in chief.

Thereupon the plaintiff, in introducing its rebuttal, introduced testimony of witnesses that this kerosene which the defendant had used in making its experiments did contain other oils and was contaminated, did contain pine oil, if the court remembers the testimony correctly, and there the plaintiff stopped. That apparently was as far as plaintiff cared to go, and possibly as far as it would need to go in impeaching the integrity of defendant's experiment, which the defendant was bound to establish, of course, by the preponderance of the evidence. In other words, if the plaintiff showing that this kerosene contained pine oil—if it has shown it, for it is a matter of witnesses and the credibility of witnesses—if the plaintiff's evidence tends sufficiently to show that this kerosene is contaminated and contains pine oil, so that they have brought the question of the experiment merely in equipose, it might be said that the defendant had failed to establish this as an experiment with kerosene, and as the court remembers it, this experiment was offered—the one in question, as an experiment with kerosene, what

could be done with kerosene. There the plaintiff halted. It is a matter of indifference what might be done with admixtures of oils, as far as this evidence is concerned, because that would simply be introducing a new phase of the case and not that for which the experiments were originally offered.

Now, the defendant offers to bring an analysis of his own oils, which may or may not tend to show contamination or admixture of pine oil; but the defendant goes further and says, "Well, if this oil was contaminated and if it contained pine oil, we have taken it and purified it, and now we will do this experiment over again and show the court a real experiment with kerosene." This seems to the court nothing more or less than a mere reassertion of its case in chief. If the defendant wanted to show the court an experiment with kerosene, it was its duty to show it to the court in its case in chief, and it undertook to discharge that duty. There is no element of surprise in the evidence of the plaintiff that the kerosene was contaminated, or tending to show that it was, because the defendant was itself apprised of the condition of its own oils.

I take it the situation is very much the same as though the defendant in a criminal case would say to the court that it would go out and take the gun with which the killing was alleged to have been made, and the cartridges, and demonstrate by experiment that the gun would not carry the distance at which the evidence tended to show that the victim was killed. Then he goes out and performs the experiment and comes back

and testifies to the court that the gun would carry only one-half of the distance at which the man was really killed—certainly very strong evidence in defendant's favor. But it develops upon cross examination of the defendant and his witnesses that there was admixture of cartridges, which would again leave the integrity of the experiment in doubt. Now, the state in rebuttal proceeds to show that the cartridge used in the experiment contained only half of the powder which was in the cartridges with which the killing was done. Certainly it would not be open to the defendant to show in sur-rebuttal, that it would be sur-rebuttal for him to take cartridges really like those in the gun which actually made the killing and again go out and do the experiment over again.

In this particular case before the court it would now involve that we take this oil that is offered by the defendant, that plaintiff take new samples of it, and go out and analyze it again and come back and tell us about it and give the defendant another opportunity to say, "If this new objection arises we will remove that and perform the experiment over again." It is merely in the nature of cumulative evidence and comes at that stage of the proceeding when the court is bound to say that this see-sawing, if it may be so characterized, from one side to the other in the matter of experiments must come to and end in the interests of the administration of justice. The evidence that is now offered by the defendant is merely an offer to perform a new experiment with real kerosene, without saying

that it did not perform it already in chief. If it did, its case is as it should be; if it did not, the offer comes too late. The objection to the experiment will be sustained. At the same time, of course, it is open to the defense or its witnesses to testify that their oil was not contaminated, or at least not contaminated to an extent that renders it other than a real kerosene experiment.

MR. SCOTT: To which the defendant desires an exception noted.

THE COURT: Note an exception.

DR. SAMUEL P. SADTLER, Resumed the stand for further

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 7. I think, Doctor, that yesterday you gave the quantity of soluble material that you found in the kerosenes we were discussing did you not?

A. The kerosene as now produced?

Q. 8. The kerosene that you washed out to get the quantity?

A. Yes.

Q. 9. To what do you consider the soluble material you found in that kerosene to constitute a contaminant?

A. I do not consider that I found any soluble element in the kerosene after the double washing treat-

ment. I have a slight weight which I quoted on the evaporation of the choloroform in the last place of decimals, six ten-thousandths of a gram, but when that evaporation took place there was no foreign odor and there was just the slight kerosene odor. I believe that the slight weight I have there is due to the fact that the chloroform had a small amount of the kerosene which could not be completely separated from the water, and therefore it simply represents the deficiencies of the method, the impossibility of getting the water free from that minute trace of the kerosene with which it had been agitated so long, and I do not recognize that from the result of my analysis and experiments that there was any soluble frothing agent left in that sample.

Q. 10. You mean after it had been washed?

A. After the complete treatment.

Q. 11. Well, from your experience and investigation in flotation phenomena, is it your opinion that the amount of soluble material which you did find in the kerosene would or would not materially affect its properties as a reagent for use in the flotation process?

A. I do not think it could possibly affect it. Taking the analysis of the kerosene A, as it was presented here in court, and before any of this washing or purifying treatment, I had found, as will be recalled from my testimony of yesterday, twelve one-thousandths of one per cent of contamina, and it is entirely possible that a trace of this or a part of this might have been some of the paraffine, in some way, which was there.

Samuel P. Sadtler

I have reckoned out on a 300 gram charge of ore, the impurity represented by that perecentage of contamination and it would be nine one-thousandths of a gram, or put in percentage and reckoned on the weight of the ore, it would be .003 of 1%. That is the amount represented by that impurity before any treatment.

Q. 12. Three one-thousandths of 1% of the total weight of the kerosene?

A. Reckoned on the weight of the ore.

Q. 13. With a charge of 25% of the kerosene?

A. Yes.

Q. 14. Do you know of any instance in the practice of flotation in which a quantity of oil or oily substance as small as three one-thousandths of one per cent of the ore, plays a part or is utilized?

A. I do not.

MR. GARRISON: I desire to object; I do not understand that this witness is proffered as a metallurgical expert. I understood he was an oil chemist. I do not understand he had been put forward as a metallurgical expert. Of course if he has been I will withdraw the objection.

THE COURT: I do not understand that the witness said he was a metallurgical expert.

THE WITNESS: I do not profess to have any knowledge of the metallurgical side of the business.

MR. SCOTT: He has given considerable study to this matter of flotation in connection with his knowledge as a chemist, and more particularly in connection with his knowledge of oils. A metallurgist would

be less competent to testify upon this point than Dr. Sadtler because a metallurgist would not have the expert knowledge of oils, which is the doctor's principal occupation.

THE COURT: You are asking him as to his particular knowledge of the process of flotation, if he knows any cases where this amount of oil has been used.

MR. SCOTT: I will withdraw the question.

Q. 15. Is it your opinion, doctor, from your investigation of flotation and your knowledge of oils and the custom of oils, that three one-thousands of one per cent of oil relative to the weight of ore could perform any useful function in affecting flotation?

MR. GARRISON: Now, it just seems to me that is a mere indirect way of producing the same result. I have no objection if Mr. Scott will proffer this witness as a metallurgical expert so that our cross examination of him may test his opinion with respect to metallurgical processes. In that event I should be willing to let this question go in, but the witness protects himself.

THE COURT: Yes, I think so; the objection will be sustained. I think you might ask him if he is acquainted with the properties of the oils, and if this small quantity of whatever he found—what effect it would have on the properties of kerosene. I do not think you should ask him to determine a metallurgical problem in the practice of the art until he has shown

Samuel P. Sadtler

himself competent. He has fairly said he has had no practical experience. The objection is sustained.

MR. SCOTT: May we have an exception?

THE COURT: The exception will be noted.

Q. 16. MR. SCOTT: Doctor, have you made any investigation relative to the solidification in water at various temperatures of the oil mixture or any ingredient thereof, such as was used at the Butte & Superior Mining Company, and more particularly as used by them upon the day that the representatives of Minerals Separation, Limited, made their inspection of the plant?

A. I have examined the oils and made some tests with reference to settling that question. I heard the testimony of Mr. Greninger that the fuel oil used that day immediately coagulated on coming in contact with the water of the flowing pulp at the temperature which existed on that day, and also that the mixture of the fuel oil, Yaryan pine oil and kerosene used for the frothing mixture that day would coagulate in the same way. The materials which I took were the Greybull fuel oil which was stated to me by Mr. Dosenbach to have been the oil used that day. That is a Wyoming paraffine and a paraffine base, as was also stated by Mr. Greninger. Now I examined that sample, that is, a portion of what was used that day, and this fuel oil at the ordinary temperature is too thick to flow from the bottle as it was shown me, and a thin film of it gotten on the side of the beaker glass shows separation of soft paraffine as a solid, small blotches of sep-

arated froth paraffine. That is probably the same substance that was referred to by Dr. McIlhiney. However, both the pine oil and the kerosene which are used in connection with this fuel oil are solvent for paraffine, excellent solvents for paraffine; and the mixture made up in the proportion as it was, as stated by Mr. Dosenbach, and as it was used that day, the mixture was 64.47% of the fuel oil, 24.30% of the Yaryan pine oil and 11.23% of kerosene of .185 specific gravity. Now, I made that mixture myself as an experiment, taking the materials in this proportion as here stated. I made that mixture entirely in the cold, simply by stirring the ingredients together entirely in the cold, and the temperature of the mixture as taken by a thermometer at the time was 18° C., which is relatively low, and I believe was under the temperature existing in the flotation mixture at the time of the visit on Sunday. I made this mixture up, and after having mixed it thoroughly by stirring in the cold, I had a perfect liquid flowing readily at this temperature of 18° C. I examined it under strong magnifying power and allowed it to flow so as to get a thin film. That thin film was a thick, continuous liquid, with no break in the continuity of the film, no separation of soft paraffine or any solid body. Then a small amount of that liquid was put into a bottle containing cold water and was shaken up energetically and the mixture perfectly disintegrated and emulsified. On examination of the appearance after this continuous agitation I could see nothing but the bunched appearance of the emulsified

Samuel P. Sadtler

oil, part of it in flocks and part of it in the compact frothy mixture on top of the water in a layer. My opinion, therefore, was, that while the fuel oil taken by itself would give some such separation, the mixture as given, the fuel oil in contact with two solvents in a perfect liquid mixture, does not separate the solid material at a temperature of 18° or at the temperature which probably existed there in the mill.

MR. SCOTT: That will be all, doctor.

CROSS EXAMINATION

BY MR. WILLIAMS:

X-Q. 17. Doctor, I understood you to say that the specific gravity of that kerosene was .185.

A. No, I didn't say that.

X-Q. 18. Just tell me what the fact is.

A. You mean the original sample?

X-Q. 19. Oh, no, the kerosene used in the mixture.

A. It was given to me as .815.

X-Q. 20. One of the methods of the manufacture of pine oil is that of steam distillation is it not?

A. That is, with reference to what is called the steam grade.

X-Q. 21. Can't you answer that question?

A. That is one method, the steam grade pine oil as distinguished from the other type of pine oil.

X-Q. 22. Do you know whether Yaryan pine oil is steam distilled or not?

A. I do not know from knowledge as to what its

exact treatment is. As to whether it is entirely obtained by steam distillation, or whether it is partly by direct, I do not know.

X-Q. 23. Is pine oil alkaline or acid?

A. If it is obtained by the aid of direct heat, it is probably acid.

X-Q. 24. Do you know?

A. I do not know with reference to any particular sample. I have knowledge that some samples of pine oil are acid.

X-Q. 25. Were you present at the Butte & Superior plant on the inspection of it made by the plaintiff's representatives?

A. I did not go out.

X-Q. 26. In your examination of the kerosene which corresponded to what was used in the two court experiments, you call that specimen A, don't you?

A. Kerosene A, it is called.

X-Q. 27. How large a quantity of kerosene did you submit to this operation?

A. I took 500 c.c., half a litre for the washing treatment that I applied myself. In this sample which is here now, it had had a previous washing, in which probably more than a litre of it was taken for the first washing by agitating in the square glass jar by the aid of the rotating agitation method. And of that I took a portion after the layer had separated. My experiments were made, as I stated, I believe, by taking 500 c.c. of the oil and the same volume of pure distilled water and slightly agitating until I had the whole

Samuel P. Sadtler

thing broken into fine bubbles, and then I allowed it to settle again.

X-Q. 28. When did you do this?

A. Last Saturday afternoon, and last Sunday afternoon.

X-Q. 29. And where?

A At the oil laboratory of the Butte & Superior mill.

X-Q. 30. And who gave you this kerosene that you washed?

A. It was furnished to me by the oil chemist there, who had identified it, and I stated that the young man who drew it from the drum, both for the amount produced here in court and for the amount which I took, was present and could testify to that.

X-Q. 31. You did not give me his name?

A. Oh, I beg your pardon, Mr. Dudgeon.

X-Q. 32. And of course you don't know as a fact where he got it?

A. I took it on his statement.

X-Q. 33. Now, in your test of this kerosene "A", the foreign material which you collected was the foreign material which was dissolved out of the kerosene by the water and in agitation, and out of the water, as I understand it, you evaporated it and got some residue?

A. That was one test, direct evaporation. The most important test, the one which yielded a quantitative test, was taking an aliquot quantity of the wa-

ter and extracting it in a separate test with the use of pure choloroform.

X-Q. 34. In that you got such part of this foreign material as possibly was dissolved by the water out of the kerosene, and then as was dissolved out of the water by the chloroform?

A. That is correct.

X-Q. 35. And your final determination was of what was left in the chloroform after you had evaporated the chloroform?

A. The chloroform was driven off by allowing it to slowly evaporate on a warm plate, and carefully noted as it got down for any foreign odor, and then weighed up anything that was left after the evaporation of the chloroform.

X-Q. 36. Having made these two cleanings, did you make another cleaning to make sure that there was no foreign material?

A. Well, I did find what I said was something, probably a foreign material, a trace.

X-Q. 37. In the second cleaning?

A. In that chloroform extraction I did find such.

X-Q. 38. In the second cleaning you did find something?

A. In the second cleaning I found .0006 of a gram, which is practically almost within the limits of the accuracy of the balance, and therefore does not mean anything very much, and the only odor was a slight kerosene odor, and I am entirely satisfied that it is perfectly legitimate to assume that a trace of kerosene was

in that water which was shaken with the chloroform, and of course it would be taken out with the chloroform.

RE-DIRECT EXAMINATION

BY MR. SCOTT:

R-Q. 39. Doctor, I would like to ask you what, in your opinion, would be the effect on the properties of kerosene as a frothing agent, of the presence of an amount of soluble matter which you have testified you found in the kerosene?

MR. GARRISON: I object, your honor, unless the doctor is qualified as an expert on frothing agents.

MR. SCOTT: Dr. Sadtler has testified to his extensive investigations, extending over several years of these frothing agents.

THE COURT: I think the doctor has testified to that, stating that there was nothing in there that could possibly affect the kerosene in its frothing effect; that this soluble matter that he found was not enough to possibly—that is the way he put it—effect the kerosene in its frothing effect.

MR. GARRISON: I don't object to the witness testifying to it, your honor understands, but I don't want him to testify to it with the qualification that he is not competent to testify on that subject. If he will commit himself as an expert on frothing agents, I am perfectly willing, but if on cross examination he said that he never pretended to know about these things,

we have all the disadvantage of his testimony and none of the advantage of cross examination.

THE COURT: I suppose there is a distinction between the things which will make a froth and the things which will make a mineral froth.

MR. GARRISON: Your honor catches my point exactly. I don't want to keep it out, but I want to— I want it to come in with some probative force, so that cross examination may develop something. If it should develop on cross examination that he did not claim to be qualified on frothing agents, that would show that his testimony should not have been admitted in the first place. If he will say or Mr. Scott will say that he is qualified as to mineral frothing agents, I have no objection.

THE COURT: I think the doctor testified to that. I think he qualified about frothing agents. Didn't you, doctor?

THE WITNESS: I do not testify as to metallurgical results, but I have had a large experience with froth production and the raising of froth in the presence of mineral; but I stop at the point where the metallurgical effects come in.

THE COURT: Well, it would not have any value except as to the metallurgical results. The metallurgical results are those which are important, not the fact that it might raise some patricle; the objection is sustained.

MR. SCOTT: The other witnesses have testified of the frothing properties of these oils independently

Samuel P. Sadtler

of the utilization of them in metallurgical processes, and experiments were performed in court that exhibited the frothing qualities of oil aside from the presence of solid matter at all, and the question as framed calls for the doctor's opinion upon the effect of this small, infinitesmal amount of soluble matter, unidentified, upon the properties of kerosene as a frothing agent.

MR. GARRISON: Has the matter been reopened for argument?

THE COURT: You may answer him if you desire.

MR. GARRISON: I have nothing further to say, except that it does seem to me that we are entitled to have the witness come down on one side of the fence or the other. We are perfectly willing, as long as he says he is qualified to give his opinion, but unless he does, the testimony is improper.

THE COURT: It becomes a conjecture then. The ruling of the court will stand.

Defendant excepted.

(WITNESS EXCUSED).

Frank G. Janney.

FRANK G. JANNEY, Recalled in behalf of defendant in sur-rebuttal, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 1. Mr. Janney, you testified before to several years' experience in flotation operations; how many years was it you stated?

A. Since 1912.

Q. 2. And your present position you said was what?

A. General superintendent of mills for the Utah Copper Company.

Q. 3. Now, in the course of your employment, to what extent have you investigated the flotation phenomena?

A. From 1912 to 1914, I spent the greater part of my time personally; since that time I have had engineers investigating the processes but I have not been actively engaged in it myself, except—

Q. 4. At how many different plants have you made investigations of flotation; how many different mines and mills, I mean?

A. Butte & Superior, Ray Consolidated Copper, Chino, Nevada Consolidated, and our own operations at Utah.

Q. 5. Have your investigations caused you to look into the quantities of oil which are necessary or effective or possible in practical use?

A. They have.

Frank G. Janney.

Q. 6. What would be your opinion as to the use of .003 of one per cent of an oil relative to the weight of ore as to having any effect one way or the other upon the flotation operation?

MR. GARRISON: I object to that, if your honor please. There is no identification here of what it is, this so-called thing that is being inquired about. Unless this witness is prepared to say that he is a prophet of the art and knows all about everything that will be discovered in the future, his evidence is of no value. If they identify anything or ask him within the things that he has examined I have no objection.

Q. 7. To save argument we will limit it to the oils that you have had experience with?

A. In all my experience I have never found an oil or a reagent that could be used in that small quantity and be effective.

Q. 8. Have you become acquainted with the properties of any considerable number of oils or not?

A. I have; in our laboratories I think we have examined about 1200 different oils and fractions of oils.

Q. 9. For what purpose?

A. Determining the properties of the oil, their floating value and the grade of concentrate and recoveries made by the oils.

Q. 10. And it is upon the knowledge so gained, is it, that you have based your answer regarding the use of .003 ot one per cent?

A. It is.

Q. 11. Were you present at the mill at the Magna

plant of the Utah Copper Company ~~when~~ upon the day when the mill was visited by the representatives of the Minerals Separation, Limited?

A. I was.

Q. 12. Were you present throughout the period of their visit?

A. I was.

Q. 13. What was your purpose in being there?

A. To assist in the securing of samples which the Minerals Separation representatives wanted, and to obtain a duplicate set of samples.

Q. 14. During the day did you or did you not observe the operation of the plant, aside from getting the samples?

A. I did.

Q. 15. What was your observation in regard to what was taking place in the first cell, I mean the first agitator of your spitz boxes.

MR. GARRISON: I object to this, it is not rebuttal. They did this test run or experiment, whatever they choose to call it, and they have produced or did not produce all the evidence they desired with respect to what they were doing and what the result was, and we gave our testimony as to what we observed and what the results were, and there the matter must rest it seems to me.

MR. SCOTT: Our witnesses testified to the operation of this plant with the quantity of oil then being used, over one per cent, and they testified to the proportion of the froth of the ordinary type with that

Frank G. Janney.

amount of oil, and then the plaintiff in rebuttal produced witnesses who denied that there was a froth on this first cell, as I remember it, they stating that it was an oil magma, or some word that they used. They stated or implied that the oil was being drawn off from the system without accomplishing any purpose. They flatly denied the testimony of our witnesses, and it seems to me that this testimony comes within the most strict definition of defendan's sur-rebuttal testimony.

MR. GARRISON: The very statement of Mr. Scott excludes it. He says their witnesses stated it, and our witnesses denied it, and now he wants to reaffirm it.

MR. SCOTT: Our testimony was directed to the plant as a whole, and this one unit was picked out by these witnesses for Minerals Separation, and it was about that that they stated that this one unit was operating differently from the rest of the plant, drawing a distinction between these things which no man ever could have anticipated would have occurred to anyone. Our witnesses having examined the thing and found it to overflow in their examination, they are not responsible and we are not responsible for not recognizing a hair-splitting distinction between the individual cells, and we think we are entitled to rebut that.

THE COURT: This was a test with a large amount of oil?

MR. SCOTT: No, the plant was running in its normal operations with something like 21 or 22 or 23 pounds of oil.

Frank G. Janney.

THE COURT: The defendant introduced testimony showing that they performed such a test run. The plaintiff then comes in and says that may be true, but that at a certain point there was a defect in the test. Now, it is quite a different case than the offer in respect to the kerosene oil. The kerosene test was offered as a kerosene test pure and simple, and when the plaintiff showed that it was not a kerosene test and there halted, the defendant should not be allowed to bring it in again. I think this is different, I think the defendant should be allowed to show that that first cell performed its normal function. I think this is fair rebuttal. The objection will be overruled.

Plaintiff excepted.

Q. 16. MR. SCOTT: The question, Mr. Janney, was to ask you to describe the operation of the first cell.

A. The first cell was operating as an emulsifier and had been operating as an emulsifier for some time as a matter of fact I think it was operating as an emulsifier since the middle of January. No concentrate was produced on that cell. As a matter of fact the gates between the first and second cells were left open, and there is no adjustment made on that cell. It is not the intention in our operations to produce a concentrate on that cell, and although a concentrate is formed of mineral bearing froth, it is not discharged. Occasionally the froth fills up to such an extent that it discharges of its own accord, but not with our intentional operations.

Frank G. Janney.

Q. 17. You might explain just what you mean by emulsifier and the relation of the emulsifier to the flotation plant proper, or the overflow of concentrate that takes place?

A. In the design of our flotation plant we use two cells for preliminary beating of the pulp before it enters the spitzkasten.

Q. 18. What is that preliminary beating for?

A. For emulsifying and distributing the oil equally throughout the pulp.

Q. 19. And those two emulsifiers are simply mixing boxes without preparation for overflow or collection of froth?

A. They are.

Q. 20. In what respect did this first cell differ from the emulsifiers that are especially provided for use as emulsifiers?

A. The function was exactly the same as the emulsifier. The same agitation; the same speed of motor, except as to the spitzkasten which was simply acting as a receiving box through which the pulp was circulating.

Q. 21. And what effect upon the overflow from the spitzkasten did the fact that the gate was open to the second cell have?

A. The water level in the first spitz was at the same height as it was in the second spitz.

Q. 22. But the second spitz as I understand is built at a lower level than the first?

A. Six inches.

Frank G. Janney.

Q. 23. And by having the water level in the first cell at the same height as that in the second, what effect was there upon the overflow of froth from the first cell?

A. Well, the froth would have to build up about six inches deep before it could discharge. As a matter of fact it would have to build up to about eight inches because the water level of the cells which are discharging concentrate is about an inch to two inches below the spitz overflow.

Q. 24. What is the character of this float that builds up in the first box of the first cell in the unit we are now discussing?

A. It is a very light aerated froth, and the fact that it lies dormant on the surface of the water, and any air that is released in the spitzkasten has to rise through that froth, the result is that we get a very light, large bubble, aerated froth.

Q. 25. Now, will you just describe the course of the pulp as it goes into the first emulsifier and proceeds down to the second cell?

A. Well, the feed is drawn from the sludge tank and flows by a launder into the bottom of the first emulsifier. This emulsifier contains a ten horse power motor, and attached to the rotary are two impellers. The motor runs at 570 r. p. m. It flows into the bottom of the emulsifier and is elevated by the impellers and discharged over the top, and from there it flows into the bottom of the second emulsifier and is elevated by the impellers and discharges from the top.

Frank G. Janney.

From the second emulsifier it flows into the bottom of the first cell. It is elevated—

Q. 26. Where it flows into the first cell, what part of the first cell does it flow into?

A. It flows directly into the mixing chamber.

Q. 27. Is that mixing chamber of the first cell any different from that of the two emulsifiers that precede it?

A. It is not.

Q. 28. After it goes into the mixing chamber of the first cell where does it proceed?

A. It is elevated by the impellers and discharged into the spitzkasten.

Q. 29. And after the pulp gets into the spitzkasten what becomes of it?

A. A portion of it is returned to the cell and a portion of it goes into the second cell through a gate between the spitzkasten.

Q. 30. The same gate you referred to before?

A. The same gate.

Q. 31. And eventually all of the pulp gets into the second cell does it?

A. It does.

Q. 32. But part of it circulates around the cell before it proceeds to the second?

A. It does.

MR. SCOTT: That is all.

Frank G. Janney.

CROSS EXAMINATION

BY MR. WILLIAMS:

X-Q. 33. In this blue print which is attached to and forms part of exhibit 251, the flow sheet of the plant, is it a flow sheet as it was operated on April 21st, 1917?

A. It is.

X-Q. 34. I notice the sampling legend has as its last item "First spitzkasten overflow." That is true is it not?

A. It is.

X-Q. 35. And when we turn to the assays, I find, "Machine No. 1, Spitz No. 1 overflow" that being the product which had 412 pounds of oil per ton of mixture—per ton of mixed concentrate and oil? That is right is it not?

A. Yes.

X-Q. 36. Now, I understood you to say that this was not an overflow at all. Is that right?

A. It was not. That sample was taken from the froth floating on the No. 1 spitz and it was called —I marked it "First spitzkasten overflow" from the fact that your representatives marked it that. My samples were marked exactly the same as your samples so that there would be no question or dispute as to the identity of the samples.

X-Q. 37. Now, Mr. Conrads was the flotation superintendent of that plant, wasn't he?

A. He was the metallurgical engineer.

Frank G. Janney.

X-Q. 38. Mr. Conrads came here and testified that that plant was operated with double spitzkastens discharging the concentrates. Do you contradict him?

A. It was a portion of the time, and as I said, to about the middle of January, that concentrate was discharged from that cell.

X-Q. 39. And when Mr. Conrads came here and testified as to operating through February and March he must have—

THE COURT: Well, well, I think it will be for the court to pass on that.

MR. WILLIAMS: I wanted to get the attitude of the witness in the matter.

THE COURT: If his testimony is in conflict with Mr. Conrads' testimony it will be for the court to determine. Of course you may point it out to him, and ask him to explain if he can, but to ask him to pass upon the credibility of another witness—

MR. WILLIAMS: I will withdraw the question.

X-Q. 40. Is there anything in this flow sheet that was furnished us to show or indicate that the first cell was used as an emulsifier?

A. Nothing.

X-Q. 41. In your extensive study of flotation which has extended over a good many years have you ever used the Australian eucalyptus?

A. I have.

X-Q. 42. In how small quantities have you used that?

Frank G. Janney.

A. I can't say definitely. I can't say.

X-Q. 43. Do you think you have ever used it in as small quantities as half a pound eucalyptus oil to the ton of ore?

A. No, I have not.

X-Q. 44. Have you used pure phenol?

A. I have.

X-Q. 45. In how small quantities have you used pure phenol?

A. I can't say without looking up my tests.

X-Q. 46. As a matter of fact it would be quite a feat of memory for you to give these proportions?

A. It would.

X-Q. 47. And you have used pure cresol have you?

A. I have.

X-Q. 48. And can you tell me in how small a quantity you have used that?

A. I can not.

X-Q. 49. Now, you mentioned a large number of mills at which—I am not quite sure I got your testimony—you tried flotation. Was that it?

A. Investigated it.

X-Q. 50. Investigated it?

A. Yes, sir.

X-Q. 51. And I take it your investigations were for the purpose of assisting the operations or directing the operations?

A. They were.

X-Q. 52. Those companies are known as the Jack ling group, are they not?

Frank G. Janney.

MR. SCOTT: I object to this question. I don't see that it is a competent, material or relevant question to anything connected with this suit.

MR. GARRISON: Here we have a rather remarkable situation of interchange of employees, of superintendents in one mill going to another mill to assist, and all of them coming here to oppose us, and I think we have a perfect right to show the interest of these various people in each other's business. It tends to weighing the credibility of the witnesses.

MR. SCOTT: No interest is shown by the question in the form as put.

THE COURT: No, it is only a single question. I think he may answer. Objection will be overruled. Read the question.

(Question read as follows: Those companies are known as the Jackling group, are they not?)

A. They are.

X-Q. 53. MR. WILLIAMS: Now, as to the Nevada Consolidated, how long ago was it that you were assisting them in their operations?

A. I think it was in 1914, I am not positive.

X-Q. 54. You testified about that in the Miami trial to a slight extent?

A. Yes.

X-Q. 55. What oil proportions were they using at the time that you assisted them?

A. Well, they varied.

X-Q. 56. Well, within what general limits?

A. About 2½ to three pounds.

X-Q. 57. And they were agitating in a Janney machine?

A. They were.

X-Q. 58. And producing a froth which carried the metalliferous mineral?

A. They were.

X-Q. 59. And these figures you gave of course were in pounds of oil per ton?

A. Yes.

X-Q. 60. How do you adjust the overflow of the type of Janney machine that was at the Utah Magna plant when it was exhibited to these representatives?

A. Through a gate which acts as a valve, in a partition between the cells. As you close the aperture you raise the height of the water in the spitzkasten.

X-Q. 61. Mr. Wicks testified to a Janney machine wherein there was a standpipe regulation of the flow level in the spitzkasten. These machines were not of that type?

A. They were not.

X-Q. 62. It was just a matter of regulating the level by controlling the overflow?

A. Absolutely.

X-Q. 63. And I take it that that method of regulating the level is apt to be varied by an increase of feed, is it not? That is to say, if the feed increases the level will go up? Isn't that true?

A. Why, yes.

Frank G. Janney.

X-Q. 64. And, on the other hand if the feed diminishes, the level will go down?

A. It will.

X-Q. 65. That is to say as compared with a standpipe overflow you haven't got anything that controls the overflow at a fixed level? Is that right?

A. That is right. That is what we have the sludge tanks for. That is to say the purpose of the sludge tank is to take up an increase of feed and carry it and so regulate to some extent the feed to the flotation machine. That is the purpose of it.

X-Q. 66. You didn't tell me what oils they used at the Nevada Consolidated at the time that you assisted them?

A. I don't remember now; we were experimenting. We used a good many oils.

X-Q. 67. They were flotation oils, of course?

A. Flotation oils, both mineral and creosote as well as wood oil.

X-Q. 68. And of course you know that creosote and wood oils contain soluble frothing agents?

A. A portion, yes.

WITNESS EXCUSED.

EDWARD W. ENGLEMANN, recalled for further

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Mr. Englemann, when you were on the stand before, you referred to your experience in flotation but I don't remember whether you stated how many years you had been engaged in operating flotation plants or investigating flotation. How long have you been?

A. Since 1913, the latter part of 1913.

Q. 2. And, generally speaking, what has been the nature of your experience since that time?

A. Well, in testing different oils on our products, determining the best mixture that would give the most efficient results.

Q. 3. Have you been employed in more than one flotation mill since you started on the subject?

A. Well, I did testing at the Utah Copper mill, did some testing at the Butte & Superior mill, and some testing work down at the Ray Consolidated.

Q. 4. Can you state in a general way, something as to how many oils you have probably investigated —you have investigated?

A. Well, upwards of 200.

Q. 5. And what was the nature of your investigation of these oils?

A. To determine the best mixture for the most efficient results and to determine the minimum amount

Edward W. Englemann.

of oil that would be consumed in obtaining these results.

Q. 6. In your experience in flotation have you ever used or found it possible to use an amount of oil as small as three one-thousandths of one per cent relative to the weight of the ore?

A. I have not been able to use that small amount of oil and obtain any results.

Q. 7. What is the smallest amount you ever were able to use?

A. About—Oh, .025%, or about half a pound, I think, is about the smallest I can ever remember of using efficiently.

Q. 8. Half a pound per ton of ore?

A. Yes, sir.

MR. SCOTT: You may cross examine.

CROSS EXAMINATION,

BY MR. WILLIAMS:

X-Q. 9. What frothing agent did you use in that small percentage, half a pound to the ton?

A. I used a mixture of—if I remember right, one mixture was of Barrett's No. 4, creosote and crude oil, and I used a mixture which we first started, I think, in the testing machine, about half of crude and half of pine.

X-Q. 10. Didn't you ever try pine oil alone?

A. Yes.

Edward W. Englemann.

X-Q. 11. Didn't you get even a little smaller amount when you used the pine oil alone?

A. Well, in the use of pine oil alone I have not been able to maintain any kind of a result with our ores. When I used the pine oil the bubbles were so delicate they would not carry the mineral.

X-Q. 12. So upon your ores you have not found that pine oil alone is a suitable oil?

A. We have not.

X-Q. 13. Now, what sort of a result did you get when you were using that mixture, about half a pound of creosote, was it?

A. Creosote and crude.

X-Q. 14. Creosote and crude?

A. Well, that was in our slime treatment. I have not been able to use as small as half a pound on our retreatment plant product, that is, heavy mineral, but our product averages about 75/100ths of copper; we maintained tailings that would run about .43 of 1% copper.

X-Q. 15. Was that good work?

A. Well, it wasn't as good work as we have done with .75 of one pound. Our average consumption will go about three-quarters of one pound.

X-Q. 16. That creosote contained a soluble frothing agent, didn't it?

A. Well, I suppose it does. It is regular coal tar creosote.

X-Q. 17. Aren't you doing some work at your

Edward W. Englemann.

plant in the way of floating freshly precipitated copper?

MR. SCOTT: I object to that as absolutely incompetent, irrelevant and immaterial and having no bearing upon any issues in the case, but a mere inquiry into confidential matters and processes other than those concerned in this suit.

MR. WILLIAMS: I submit that he has testified as to his experience at his plant, and I am going to find out about some of them. Of course I am not going to press it into anything that will—

MR. SCOTT: I insist upon the objection. The question is an absolute bold attempt to pry into confidential affairs and has no relation to this suit, none that is possible of explanation.

THE COURT: I can not say that. I will have to trust to counsel. Even if it is confidential, if it came down to the point of the quantity of oil or something that would show the experience of this witness it can not be helped. Counsel at the same time says he is not seeking that. I think we will have to trust to his statements. It is cross examination. The objection is overruled.

MR. WILLIAMS: In view of the objection of counsel I will say that I am not seeking any information that will be of the slightest value to my clients, But I am seeking knowledge that has a bearing upon the point in issue.

X-Q. 18. (Question read as follows: "Aren't you

doing some work at your plant in the way of floating freshly precipitated copper?")

A. We have done some experiments.

X-Q. 19. MR. WILLIAMS: Well, now, in this work, in what form have you produced the float of the freshly precipitated copper? In the form of a froth?

A. Yes, sir.

X-Q. 20. I propose to ask you just the essential question. I haven't any desire for anything else than what I determine essential and if you will just answer me directly I guess we won't get into any confidential disclosures. Now, for the production of that floating mineral froth, what frothing agent did you use?

A. The same frothing agent that we used in the regular operations.

X-Q. 21. And in what proportions?

A. 75% Barrett's No. 4 and 25% of fuel oil.

X-Q. 22. Now that is the relative proportion of one oil to the other.

A. Yes, sir.

X-Q. 23. Now, what was the proportion of this total oil mixture per ton of material treated?

A. You mean in the testing that we are doing?

X-Q. 24. Of course you make your computations on the basis of that?

A. Well, I don't quite get you.

X-Q. 25. Just give me the figures on the basis of tonnage of dry material treated.

Edward W. Englemann.

A. Are you figuring on the testing work we are doing or the actual operations in the plant? Are we speaking now of the—

X-Q. 26. I am speaking now of the testing work that you are doing.

A. Why, in these tests we average about a pound and a half of oil per ton.

X-Q. 27. And is that true of all the tests?

A. No, that is just true of this soluble copper testing that you are speaking of.

~~X-Q. 28. But it is true of all the soluble copper testing that you are speaking of.~~

X-Q. 28. But it is true of all the soluble copper tests is it?

A. Well, it will average that. We really are not trying to determine the amount of oil we will have to use on this, it is a question of getting the soluble copper. That is the object of the tests.

MR. WILLIAMS: That is all.

WITNESS EXCUSED.

James Walter Dugeon.

JAMES WALTER DUGEON, a witness called in sur-rebuttal after being first duly sworn, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Mr. Dudgeon, will you please state your full name?

A. James Walter Dudgeon.

Q. 2. And your residence?

A. 939 West Granite, Butte.

Q. 3. You are employed at the Butte & Superior Mining Company?

A. I am.

Q. 4. In what capacity?

A. I am experimental man in the flotation laboratory.

Q. 5. What do you know about the source of the kerosene "A" that was given to Dr. Sadtler for analysis, as testified to by him this morning?

A. The sample of kerosene "A" which was given to Dr. Sadtler for analysis was drawn from the container along with the samples which we used here in court, and on the same day.

Q. 6. You have personal knowledge of that fact?

A. I drew the kerosene myself and marked the bottles.

MR. SCOTT: That is all.

James Walter Dudgeon.

CROSS EXAMINATION,

BY MR. GARRISON:

X-Q. 7. What was this container?

A. It was a steel drum.

X-Q. 8. Was it the original package that came from the person from whom you purchased it?

A. I have no knowledge of that. It was the container from which I was told to draw the kerosene.

X-Q. 9. What I am trying to find out is it the thing that the kerosene came in, or is it something in which the kerosene was put after it gets to your plant?

A. It is the tank which we have at the plant, and which we used to keep the kerosene in.

X-Q. 10. And you drew it off into what, do you say?

A. Into two litre glass bottles.

X-Q. 11. And when did you draw it?

A. It was on the 16th of April as near as I can remember of this year—the samples that were used.

X-Q. 12. And what samples do you refer to that were used?

A. Just the quantity of kerosene that we drew for this case, to use in experiments about the laboratory.

X-Q. 13. And you kept that up there at the mill, around the laboratory?

A. Yes, they were kept there, marked.

X-Q. 14. And these bottles that you drew, you found in the laboratory on the day that you gave these samples to Dr. Sadtler, is that correct?

A. Just a minute, until I understand the question.

James Walter Dugeon.

X-Q. 15. (Question read as follows: "And these bottles that you drew, you found in the laboratory on the day that you gave these samples to Dr. Sadtler, is that correct?")

A. This bottle, or this sample of kerosene about which Dr. Sadtler testified was one which I had put away as the duplicate samples of the ones we were using in court.

X-Q. 16. What I want to know is actually did you draw off two bottles?

A. No, there were four or five I don't remember just exactly how many.

X-Q. 17. However many there were, let's say five for an arbitrary number. What did you do with those five bottles after they were drawn off, the physical bottles, what did you do with them?

A. I took them to the laboratory.

X-Q. 18. What laboratory?

A. Our flotation experimental laboratory.

X-Q. 19. Where is that?

A. At the Black Rock plant of the Butte & Superior Mining Company.

X-Q. 20. And some kerosene from one of these bottles that we have assumed were five,—was that what was given to Dr. Sadtler?

A. Yes, sir.

X-Q. 21. And some of this same kerosene you testified was the kerosene that Dr. Phillips used? Is that correct?

A. I have no knowledge of what Dr. Phillips used,

as I was not personally present when he made his experiments.

MR. GARRISON: That is all. Now, if your honor pleases, I ask to have stricken out all of the testimony of Dr. Sadtler respecting the analyses that he made of the kerosene. The only way in which he identified it as the kerosene used by Mr. Phillips was by referring to Mr. Dudgeon. Mr. Dudgeon now says he has no knowledge as to what kerosene Mr. Phillips used. Therefore the testimony of Dr. Sadtler is left without any basis whatever to stand on.

MR. SCOTT: We will call another witness on that.

THE COURT: On the promise of counsel, the motion will be denied.

ARTHUR WELLSLEY HACKWOOD, a witness called in sur-rebuttal, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 1. State your full name.

A. Arthur Wellsley Hackwood.

Q. 2. You are employed by the Butte & Superior Mining Company?

A. Yes, sir.

Q. 3. In what capacity?

A. I am in charge of the flotation laboratory directly under Mr. Dosenbach.

Arthur Wellsley Hackwood

Q. 4. And you live in Butte, Montana?

A. Butte, Montana.

Q. 5. Will you state what you know about the kerosene A, which was used by Mr. Phillips in demonstrations made in this court?

A. It was on the 16th of April when we were preparing material to bring to the court, from the laboratory, I asked Mr. Dudgeon to get a number of samples of kerosene from a tank, steel drum that we have there, that this kerosene is stored in. I asked him to bring a number of bottles to the laboratory. I stood in the door and watched Mr. Dudgeon—I could see him right out of the laboratory, and saw Mr. Dudgeon get the samples right out of the barrel into these bottles, and we brought them up and took one of these bottles for a duplicate sample to keep for use as we do with all oils taken at the plant, that is, whether carload shipments, small samples—no matter what they are, we keep a sample for reference in the laboratory at all times. And one of these bottles was put away there with the rest of them marked properly and the date it was taken. This was a sample and a representative sample of the same oil that I gave to Dr. Phillips to use for his experiment.

Q. 6. You mean that you gave Dr. Phillips one of these several bottles?

A. Yes.

Q. 7. And you saw all the bottles drawn out, you say?

A. I saw all the bottles drawn out.

Arthur Wellsley Hackwood

CROSS EXAMINATION

BY MR. GARRISON:

X-Q. 8. When were these bottles filled?

A. I think it was on the 16th of April.

X-Q. 9. And when were Dr. Phillips' photographs made?

A. I don't know.

X-Q. 10. You don't know with what he made the photographs then, do you?

A. I saw him run the experiments upstairs with the kerosene; I don't know the date; I don't remember the date.

X-Q. 11. How long after you had had these bottles filled was it that Dr. Phillips made the experiment that you saw him make that you have just spoken of?

A. I don't remember the date.

X-Q. 12. I didn't ask you the date. I asked you how long ago was it. Was it an hour or ten hours, or was it a week?

A. I don't know that; I don't know the length of time.

X-Q. 13. Can't you give us any guess at all?

A. No. It was some time during the trial, since April 16th to the time he made the demonstration in court is all I know.

X-Q. 14. And that is the best means you have of describing that date, is it?

A. On the date that he did it, yes, sir.

X-Q. 15. And where were these experiments made, the part you say you saw?

A. Upstairs in the laboratory we have fitted up; upstairs in the jury room.

X-Q. 16. And the kerosene that he used upon that occasion, where did you see him get that? Where did he get that from?

A. I handed him the bottle myself.

X-Q. 17. You haven't answered my question yet. Where? Where, I said? Where?

A. Out of—

MR. SHERIDAN: Let the witness answer the question.

MR. GARRISON: Yes; let the witness answer the question. Where?

X-Q. 18. (Question read as follows: "And the kerosene that he used upon that occasion, where did you see him get that? Where did he get that from?)

THE COURT: Now the witness has answered it hasn't he?

X-Q. 19. MR. GARRISON: All I want to know is where?

A. Out of one of the bottles that I gave him.

X-Q. 20. Well where, sir; where were you? In what locality? What place?

A. Upstairs in the jury room.

X-Q. 21. And where had that bottle been in the meantime?

A. In the room all the time; upstairs in the room.

Arthur Wellsley Hackwood

X-Q. 22. And the sample that was given to us, where did that come from?

A. Out of one of those bottles; probably the same bottle.

X-Q. 23. You are not sure?

A. No, I am not sure. It was out of one of the representative bottles, anyhow that contained it.

X-Q. 24. What was the size of this bottle?

A. A two-litre bottle.

X-Q. 25. Well, give it to me in ounces. I know a little bit about ounces but I don't know a thing about litres. How much would two litres be in ounces?

A. I think there is about 29 c.c. to an ounce; somewhere around that.

X-Q. 26. Well, figure it out for me; I am not doing this for amusement. I really don't know. When I go into a drug store I ask for four ounces or six ounces or eight ounces. I do not speak in terms of litres. Can you give it in pints or quarts or gallons?

A. Probably about two quarts. If someone will give me the exact number of cubic centimeters to an ounce I will figure it out.

X-Q. 27. There's a bottle sitting on that experiment table. Is that a two litre bottle?

A. That is a 2500 c.c bottle.

X-Q. 28. Well, is that a two litre bottle?

A. No.

X-Q. 29. What is it?

A. It is a two and a half litre bottle.

X-Q. 30. Then a two litre bottle would be a little smaller than that?

A. Yes, sir.

X-Q. 31. Isn't it a fact the sample you gave us was out of a bottle about one-sixth or one-eighth the size of that?

A. I never gave you a sample out of Dr. Phillips' bottle. Probably out of a bottle like that.

X-Q. 32. Do you know out of what bottle you did give us the sample?

A. No, I do not.

X-Q. 33. Then you do not know whether we got a sample at all of the stuff that Dr. Phillips used, do you?

A. I do not know; no, sir.

RE-DIRECT EXAMINATION

BY MR. SCOTT:

R-Q. 34. You—Who handled the sample to the representative of the Minerals Separation if you know?

A. I do not know.

MR. GARRISON: Now, if your honor please, we move to strike out Dr. Sadtler's testimony respecting this kerosene. It rests upon absolutely no proof whatever that it was the material.

THE COURT: It would depend upon tracing it up through the testimony of so many witnesses that the court would not be prepared to say that the sample is not identified or that it is identified. At the present

time the motion will be denied. If the sample is not similar to that used in the test of course the court will disregard the testimony in relation to it. The exception will be noted.

MR. GARRISON: In view of your honor's undertaking to trace it up I do not know that I want any exception. That is the reason I did not crave one.

BEN H. DOSENBACH, Recalled in sur-rebuttal, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

THE COURT: I want to say right now, if there is any tracing to be done, and if either party on either side expect any value from it, I will expect them to do the tracing, both sides. You may proceed, Mr. Scott.

Q. 1. MR. SCOTT: Mr. Dosenbach, do you agree with the statement advanced by Dr. Grosvenor in connection with the moving pictures that particles oiled with sufficient oil to cause them to adhere together will not adhere to an air bubble?

A. I do not agree with the doctor.

MR. GARRISON: I object to that. How can this be sur-rebuttal testimony? I respectfully submit it is not in any aspect of the case.

MR. SCOTT: There is a theory brought forward the first time upon rebuttal, something that was never

injected into this case before, the whole theory of these moving pictures.

THE COURT: Please read the question.

Q. 2. (Question read as follows: "Mr. Dosenbach, do you agree with the statement advanced by Dr. Grosvenor in connection with the moving pictures, that particles oiled with sufficient oil to cause them to adhere together, will not adhere to an air bubble?")

THE COURT: Well, Mr. Scott, what have you to say?

MR. SCOTT: My point is that this is an entirely new aspect of the case introduced for the first time in rebuttal, this proposition that particles oiled with sufficient oil to adhere together will not adhere to an air bubble. It is an entirely new angle of the case injected for the first time in rebuttal.

MR. WILLIAMS: Mr. Scott, didn't you ask that question of Prof. Bancroft by way of anticipation of the moving pitcures?

MR. SCOTT: I don't recollect it.

MR. WILLIAMS: I recollect quite distinctly that you put that question to Prof. Bancroft.

MR. SCOTT: Well, if you will produce it. I can't remember really, in the course of this trial.

THE COURT: Very well, let him answer the question, the objection will be overruled. He has answered.

Q. 3. MR. SCOTT: Can you corroborate your statement by actually lifting such a particle with an air bubble?

Ben H. Dosenbach.

A. I can.

Q. 4. Will you do so?

A. Yes.

MR. GARRISON: Now, if your honor pleases, we think this is not sur-rebuttal at all.

THE COURT: Oh, it might be. If this is material introduced by Dr. Grosvenor as a new experiment I think they would have a right to show whether it would do so.

~~A. Yes.~~

MR. GARRISON: Yes, I agree with you on that.

THE COURT: If it is a new matter, a new matter brought out— It is called sur-rebuttal, it is simply their rebuttal of material of yours.

MR. GARRISON: Your honor and I agree entirely upon the principle. The question is whether the case meets the principle. My idea is that they have gone over this matter with their professional witnesses —and by that I do not mean any disrespect. I mean their expert witnesses. And these experts said what they had to say about it. Dr. Grosvenor said what he had to say about it, and if they feel that our people have infringed upon the work of their testimony, they certainly can not now come and offer cumulative testimony.

THE COURT: No, the case is not to be tried over again, but there seems to be a difference whether this was gone into in the former testimony.

MR. GARRISON: I think we can show that they went over this with Prof. Bancroft.

THE COURT: Let's see it.

MR. WILLIAMS: And then the other point is that the statement has not been correctly quoted; that Dr. Grosvenor did not say that lifting was impossible under those conditions.

THE COURT: Well, let us see what the testimony is; hadn't you better find it.

(Short recess was taken).

THE COURT: What is it you say that Dr. Grosvenor testified?

MR. SCOTT: I cannot quote his exact language, but it was to the effect that the particles of matter, if sufficiently oiled to adhere together, would not adhere to air bubbles; that is if we had an aggregation of particles sticking together by the adhesion of the oil, that that aggregation would not stick on to an air bubble, and Dr. Grosvenor illustrated that with particles of appreciable size, little discs of aluminum, and regardless of whether the comparison was touched on by Prof. Bancroft or not, which I cannot remember, in view of the fact that Dr. Grosvenor illustrated this in the moving pictures and also on the court's desk with large particles of aluminum, without any reference to flotation, my purpose was to show that particles of the size which are actually dealt with in flotation, when particles of that size are used that they do adhere, regardless of whether they are oiled or not, whether they have oil enough to adhere together or not, and I propose to have Mr. Dosenbach repeat this with Cattermole granules, which are agglomerations of

Ben H. Dosenbach.

particles held together by the adhesiveness of the oils upon them. My object is to show that. To show that particles a thousand times as heavy as the air bubbles will not stick to them is absolutely without probative force, and is only calculated to be misleading to the mind, because we do not claim that these forces are infinite and will lift anything, but we do claim that within the sphere of flotation, that the quantity of oil on the particles is absolutely immaterial.

THE COURT: Repeat your question.

Q. Do you agree with the statement made by Dr. Grosvenor to the effect that particles oiled with sufficient oil to cause them to adhere together, will not adhere to an air bubble?

A. I do not agree with Dr. Grosvenor.

MR. GARRISON: Wait a minute. In the first place, I think we are entitled to have what Dr. Gorsvenor said quoted. I don't think it is fair to summarize it this way.

MR. SCOTT: I will reframe the question.

THE COURT: You cannot always go back to the record and quote the exact language; it can be quoted in substance. Suppose the record were not printed.

MR. WILLIAMS: We claim that he does not give it in substance.

THE COURT: Well, look it up and see. If it is not practically correctly stated, he should reframe his question.

MR. WILLIAMS: I will briefly outline what Dr. Grosvenor did say for the purpose of showing that

Mr. Scott did not state what Dr. Grosvenor said. Dr. Grosvenor started in with his first series, scene one, and gave the six milligram weight as the maximum lift which could be made with a captive bubble manipulated as gently as possible, with an amount of oil materially in excess of that required by the Cattermole process; that is to say, he started with the proposition that the maximum lifting power of a comparatively lightly oiled metallic particle was 6 mg. He took the maximum weight and he said that it was the maximum weight, and by that, of course, he necessarily said that if you get a lighter particle and you have it oiled, it certainly would be lifted. Now, this witness proposes to take the time of the court in corroborating the statement of Dr. Grosvenor that if a particle weighs six milligrams or less and it is oiled, the air bubble will lift it, and that is all there is in this question.

I speak of this with some knowledge, because at the Miami trial a whole day of the court's time was wasted with this sort of corroboration, alleged to be contradiction. It seems to me that it is perfectly foolish to go into it. Dr. Grosvenor has said that six milligrams is the maximum lift of an oiled particle, and this witness is going to show that you can take less than six milligrams and lift it. He can take little oiled particles, light particles such as are present in flotation, and lift them. Dr. Grosvenor said he could. What is the use of giving the time of the court to such corroborations which show absolutely nothing and indicate noth-

Ben H. Dosenbach.

ing of power or anything else, when it is nothing else, essentially, but a corroboration of the scientific investigation of Dr. Grosvenor.

MR. GARRISON: Now, from the other angle, if your honor please, on page 1111 of the direct examination of Dr. Bancroft, the question was asked him by Mr. Scott:

"Q. 121. Does it seem probable that one might draw a conclusion that air bubbles do not attach themselves to metallic particles coated with sufficient oil to produce adhesion?"

That is the exact question, practically, asked of this witness, and Dr. Bancroft answered as follows:

"A. If you are working with a sufficiently large particle, that would be the natural conclusion to draw from the experimental evidence, if you did not analyze it, but it would be an inaccurate conclusion for the simple reason that it it sot so.

"Q. What would be the more accurate way of putting it?"

And then Dr. Bancroft begins and answers for the rest of that page and part of the next page, and then Mr. Scott asked him to give some illustration of the matter and he answers again for a page and three quarters. Mr. Scott brought this matter in and asked his own witness, and got the witness to say just what he wanted him to say, or at all events what he did say, and we got Dr. Grosvenor to say what he said, and what he said makes no difference. He cannot now

Ben H. Dosenbach.

bring in another witness to go over this field again that he brought into the case himself.

MR. WILLIAMS: Following that statements, the particular titles to which it is directed are as follows:

"AIR BUBBLES DO NOT READILY ATTACH THEMSELVES TO OIL GLOBULES AND HAVE SLIGHT, IF ANY, LIFTING POWER WHEN ATTACHED.

"AIR BUBBLES DO NOT ATTACH THEMSELVES TO METALLIC PARTICLES COATED WITH SUFFICIENT OIL TO PRODUCE ADHESIVENESS."

Now, in connection with that title, Dr. Grosvenor gave a very full explanation. He said that he used the words "air bubbles do not attach themselves to metallic particles," for the reason that the air bubbles attach themselves to the oil coating of the metallic particles, and that was the meaning and intent, and that it was not intended in any manner to say that if oil coated particles were of sufficiently light weight, that air bubbles could not be made to make an attachment of the oil on the oil coating of the particle to the oil lining of the bubble, and that there would be a lifting power, less than that of six milligrams. That explanation—I think it has not been read to the court, and I think it would perhaps be well to read it, as follows, from page 2534 of the record.

"Since we have seen that there is some amount of oil which will prevent direct attachment of mineral to

Ben H. Dosenbach.

the bubble, we are called upon to seek some indication of the line of demarkation at which the mineral ceases to become indirectly attached and becomes directly attached to the bubble film. A little thought, a moment's consideration, will convince one that if there is sufficient oil on the mineral to serve as a medium of attachment to another particle of mineral, there should be sufficient oil to serve as a medium of indirect attachment to an air bubble. A minute quantity of the oil will be required to supply the air bubble with its film, but even though the air bubble is 100 times the diameter of the particle and, therefore, possesses, ten thousand times the surface, the thickness of the film required by the bubble is only ten one-hundred-millionths, or sufficient to alter the thickness of the layer on the particle by about ten one-hundred-thousandths of an inch in thickness. For this rough comparison it makes no difference that the bubble is spherical and the particle is a cube. If the particle starts with a film about thirty-one-thousandths thick (Cattermole proportions) it will still have left enough oil for coating the bubble to furnish it with a layer twenty one-hundred-thousandths thick, or twenty thousand one-hundred-millionths or two thousand times as thick as the oil film on the surface of the bubble. So that it is important to observe whether under these conditions the drawing of the oil together (i. e. the reduction of the film on the particle from the remaining twenty one-hundred-thousandths to the adsorption layer) will furnish enough excess oil with that held to the upper sur-

face of the mineral by adsorption and that on the bubble, to produce an intermediate layer of oil between the mineral and the bubble, capable of necking off and producing indirect weak attachment.

"Again we shall compare the unoiled aluminum disc with the two oiled aluminum particles; the former weighing fifty milligrams and each of the latter being about 25 mgs. The two latter, however, have been oiled with cottonseed oil, specific gravity .92 and weighing .26 milligrams, about nine-tenths per cent of the weight of the aluminum particle, and producing a layer of oil about thirty one-hundred thousands of an inch thick on the surface of the aluminum. This layer on the surface of a material ground to 80 mesh will require between 4 per cent and 8 per cent of oil on the mineral by weight. It is seen that the air bubble peels off from the surface of the particle after substantial attachment, and careful examination of the pictures, highly magnified shows that there is distinctly something between the air bubble and the mineral particle. That this amount of oil is sufficient to produce adhesiveness we will show by the ability to pick up one oiled particle with the other, and the excellent degree of adhesiveness that rsults."

Now, the whole purpose and intent of that title is that this is an experiment in which the air bubble is not directly attached to the metallic particle because there is enough oil there to produce an attachment of oil to oil.

THE COURT: Your understanding is that Dr.

Grosvenor did not say that two oiled particles which adhere together could not be lifted by the air bubble?

MR. WILLIAMS: Not for a moment.

MR. SCOTT: The moving picture bore that label in the biggest letters that could be displayed on the screen, and I think the indirect nature of the photograph and of the explanation read by counsel which was given by the witness, are full justification for the claim that this thing is left in obscurity. As I had forgotten, Professor Bancroft stated that particles oiled with sufficient oil to adhere together would adhere to an air bubble unless they were too large. He said they would adhere unless they were simply beyond the range of the forces involved. Then Dr. Grosvenor in a manner that is not at all clear to me put forth his unqualified proposition that air bubbles do not attach themselves to metallic particles coated with sufficient oil to produce adhesiveness, and he illustrates it to this court by using particles so large that they are very apt to cause misunderstanding.

THE COURT: Suppose we take his testimony on your construction for the sake of argument, then you are simply disputing a square issue between himself and Prof. Bancroft.

MR. SCOTT: He has illustrated his side of the controversy by exhibiting to the court the inability of the bubble to lift particles which are so heavy that it would be absurd to be expected them to be lifted, and that might lead to a false impression.

THE COURT: No, no, I think we are guarded

against that; I think we can take his testimony at its own value. Prof. Bancroft testified to one state of facts about it, as was proper in your case, and in contradiction of that Dr. Grosvenor has testified to another state of facts, that is, he simply has denied it, and the matter rests there. If I allow this witness now to show an experiment before the court, it would simply be repeating what Prof. Bancroft said. I am inclined to repudiate such a construction of Dr. Grosvenor's testimony.

MR. SCOTT: Well, that puts a different face on it.

THE COURT: Objection sustained.

Plaintiff excepted.

WHEREUPON an adjournment was taken until 2:00 p. m. May 15, 1917.

Tuesday, May 15, 1917, 2:00 P. M.

JAMES WALTER DUDGEON, Recalled, testified, as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 22. Mr. Dudgeon, just before recess this question was put to you: "And some kerosene from one of those bottles which we have assumed to be five, was that given to Dr. Sadtler?" To which you answered "Yes." The next question, "And some of this same

James Walter Dudgeon.

kerosene you testified was the kerosene that Dr. Phillips used, is that correct? A. I have no knowledge of what Dr. Phillips used, as I was not present when he made his experiment." What experiment did you refer to there?

A. The experiment at the laboratory at the time he was taking the pictures.

Q. 23. Were you present during any experiment that he made?

A. I was.

Q. 24. What experiment was that?

A. The experiment with the bar mixer in court.

Q. 25. You were here personally and saw that experiment?

A. Yes.

Q. 26. It was assumed this morning that you meant that it was five bottles from the laboratory of the Butte & Superior mill; was it in fact five bottles?

A. It was.

Q. 27. Tell us what became of those bottles?

A. One of those five bottles was kept in the laboratory for a reference sample, and the other four were brought to the Federal Building and placed in our laboratory in the jury room on the third floor.

Q. 28. What was the description?

A. Kerosene A; 4-16-17.

Q. 29. That was put on a label was it?

A. It was.

Q. 30. On each of the bottles?

A. On each of the bottles.

James Walter Dudgeon.

Q. 31. Who brought the four bottles to the laboratory in the post office building?

A. Well, they came with the rest of the laboratory equipment from the plant in a wagon.

Q. 32. Who had charge of the transportation of them from the mill laboratory to the post office?

A. Mr. Hackwood was directly in charge.

Q. 33. Now, you were present when Mr. Phillips performed the experiment in the court room. Did you see what oil he used?

A. Yes.

Q. 34. Did you see what kind of container it was taken from?

A. I did.

Q. 35. What was that container?

A. It was a small eight ounce bottle.

Q. 36. Who took the kerosene from that bottle for the experiment which Dr. Phillips performed?

A. Dr. Phillips himself.

Q. 37. You saw him do it?

A. I did.

Q. 38. Did you yourself have occasion to take any kerosene from that bottle?

A. I did.

Q. 39. And what was the occasion of your taking kerosene from that botle?

A. In order to give the Minerals Separation representative a sample of the kerosene.

Q. 40. Did you give them a sample?

A. I did.

James Walter Dudgeon.

Q. 41. Do you know which of their representatives it was?

A. As I remember, it was Mr. Chapman.

Q. 42. And you say that was taken from the same bottle that Dr. Phillips took his from for the experiment?

A. It was.

Q. 43. I think you testified this morning that you gave Dr. Sadtler a sample of kerosene from the one large bottle which was left at the mill?

A. I did.

Q. 44. And in doing so did you take any precaution to see that you were taking it from one bottle of the five which you had drawn of kerosene A?

A. I did, by looking at the tag which I had placed thereon the day I drew the samples from the container.

Q. 45. What do you know about this small bottle—I think you referred to it as an eight ounce bottle—that Mr. Phillips took the kerosene from for his experiment—and that you poured a sample from for the representative of Minerals Separation, Limited?

A. Before that experiment was performed in court, Mr. Hackwood and I segregated the necessary equipment to perform that experiment, and this bottle of kerosene was placed in the box along with the other equipment and brought to the court room.

Q. 46. Where was it taken from to put it in the box to be brought to the court room?

A. From the equipment that Mr. Phillips had in doing his experiments.

James Walter Dudgeon.

Q. 47. And that is the extent of your knowledge of the small bottle of kerosene?

A. Yes.

CROSS EXAMINATION

BY MR. GARRISON:

X-Q. 48. The sample of the oil that Mr. Phillips used was furnished by you to Mr. Chapman, representing the plaintiff, from this eight ounce bottle that contained the kerosene with which Mr. Phillips did his experiment; is that correct?

A. I have previously said that I had no knowledge of the kerosene with which Mr. Phillips did his experiment in the laboratory for the pictures.

MR. GARRISON: Read the question.

X-Q. 49. (Question read as follows: "The sample of the oil that Mr. Phillips used was furnished by you to Mr. Chapman, representing the plaintiff, from this eight ounce bottle that contained the kerosene with which Mr. Phillips did his experiment; is that correct?")

A. That is correct.

X-Q. 50. And what personal knowledge have you of where the contents of that eight ounce bottle came from immediately before they got into the eight ounce bottle?

A. As I have stated twice before, I have no knowledge of where that bottle that Dr. Phillips used in his

James Walter Dudgeon.

experiment in the laboratory in producing the pictures, came from.

X-Q. 51. I am not asking you a word, sir, about producing the pictures. I am asking you about the experiment that you say you saw. I am going to entirely confine my question to that, so this question is directed to the experiment which you say you saw. Now read the witness the question with that explanation.

X-Q. 52. (Question read as follows: "The sample of oil that Mr. Phillips used was furnished by you to Mr. Chapman, representing the plaintiff, from this eight ounce bottle that contained the kerosene with which Mr. Phillips did his experiment; is that correct?" "And what personal knowledge have you of where the contents of that eight ounce bottle came from immediately before they got into the eight ounce bottle?")

A. I have no knowledge of where that sample came from directly before it was put into the eight ounce bottle.

MR. GARRISON: That is all.

(WITNESS EXCUSED).

ARTHUR WELLSLEY HACKWOOD, recalled testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 35. You testified this morning that you saw Mr. Dudgeon I think, and directed him to draw several bottles of kerosene "A" from the container at the laboratory of the Butte & Superior mill. It was assumed there were five bottles. Do you know what is the fact as to how many bottles there were so drawn?

A. It was five.

Q. 36. And were they identified in any way?

A. They were all marked and labeled with the date that they were drawn.

Q. 37. And who marked them, Mr. Dudgeon or you?

A. Mr. Dudgeon marked them.

Q. 38. And what became of those bottles?

A. Four bottles were brought down to the laboratory here in the Federal Building, and one bottle was kept at the plant.

Q. 39. And who brought them, or in whose charge were they brought?

A. They were in my charge.

Q. 40. Have you any knowledge that the bottles that were finally delivered here were the same bottles that Mr. Dudgeon drew?

A. They were.

Arthur Wellsley Hackwood

Q. 41. Were you present in the court room when Mr. Phillips performed the experiment with the bar mixer, I think, with 25% of kerosene?

A. I was.

Q. 43. What kerosene did he use?

A. Out of the same bottle that I furnished him upstairs to perform his experiment with.

Q. 44. And what bottle was that that you furnished him upstairs to perform his experiment with?

A. A small eight ounce bottle.

Q. 45. And who filled that small eight oz. bottle, and what was it filled from?

A. I filled it. I filled it from one of the bottles I brought from the plant.

Q. 46. Of the kerosene "A"?

A. Of the same kerosene.

Q. 47. And it was from this eight ounce bottle that Mr. Phillips used the kerosene for his experiment, you say?

A. Here in court, it was.

Q. 48. Who brought that eight ounce bottle down from the laboratory?

A. I did.

Q. 49. And did you see Mr. Phillips perform his experiment?

A. I did.

Q. 50. Did you see him pour the oil or the kerosene into the mixer?

A. Yes.

Arthur Wellsley Hackwood

Q. 51. Was there any marking to your knowledge on the small eight ounce bottle of kerosene?

A. Why, yes, it was marked "kerosene."

Q. 52. And who did that?

A. I did when I filled the bottle; I marked it "kerosene."

Q. 53. Was there any other kerosene around the Post Office laboratory at that time?

A. Kerosene—The other bottles of that—from the same container, representative samples.

Q. 54. No other kerosene except this kerosene "A." that you brought down in the four bottles?

A. No.

Q. 55. Is that bottle still in existence, this eight ounce bottle bearing that marking?

A. Yes, it is here.

Q. 56. Have you it with you?

A. No, I haven't got it; I can send up and get it. It is in the same box. Mr. Dudgeon can get it.

Q. 57. What about the eight ounce bottle; where has that eight ounce bottle been since Mr. Phillips used it?

A. It has been in the laboratory all the time since we took the stuff back upstairs after he finished his experiment.

MR. SCOTT: You may cross examine while we are waiting for the bottle.

MR. GARRISON: Do you want to put the bottle in?

Arthur Wellsley Hackwood

MR. SCOTT: I will just produce it; I don't think there is any use in putting it in.

CROSS EXAMINATION,

BY MR. GARRISON:

X-Q. 58. Now, Mr. Hackwood, how long before Mr. Phillips did his experiment in the court had you brought these four bottles that you speak of, to the Federal Building?

A. The bottles were brought from the plant on April 16th. As to the date—the exact date the experiments were performed in court, I don't remember.

X-Q. 59. I think it was about the 24th that Mr. Phillips testified.

A. Yes.

X-Q. 60. What was the size of these bottles?

A. That we brought from the plant?

X-Q. 61. Yes.

A. They were two litre bottles.

X-Q. 62. And all the five bottles were two litre bottles, were they?

A. Two litre bottles; but only four of them that were brought to the Federal building.

X-Q. 63. There were five initially?

A. Five initial bottles.

X-Q. 64. And four you brought here?

A. Yes.

X-Q. 65. And these were four two litre bottles?

A. Four two litre bottles.

Arthur Wellsley Hackwood

X-Q. 66. And, at the time that Mr. Phillips did that experiment the other three bottles were full were they, and the other bottle out of which you poured the eight ounce contents was full except what you had poured out; is that correct?

A. Why, we have run the experimental tests over, the experiments we performed for the court, out of these bottles in the laboratory. Outside of that they were just the same.

X-Q. 67. That is, they had in them whatever they actually had had in them excepting what you had taken out to do experiments with, is that correct?

A. Yes, sir.

X-Q. 68. Now, do you know anything about the kerosene oil that was furnished to Dr. Sadtler, personally?

A. At the plant?

X-Q. 69. Read the witness the question. I mean the kerosene oil that Dr. Sadtler testified that he got and which he analyzed?

A. I was not present when he got it.

X-Q. 70. So you don't know anything about it?

A. No, I don't know anything about it.

RE-DIRECT EXAMINATION.

BY MR. SCOTT:

R-Q. 71. Is this the eight ounce bottle you refer to?

A. That is the same bottle, yes, sir.

R-Q. 72. Did you say you marked that bottle?

Arthur Wellsley Hackwood

A. I marked the label, yes, sir.

R-Q. 73. Do you know, as a matter of fact whether that bottle was—contains the same oil that was left in it when—after Dr. Phillips performed his experiment and after Mr. Dudgeon gave the sample to the Minerals Separation representative?

A. It should be.

R-Q. 74. You don't have any knowledge of its being changed?

A. No knowledge of its being changed. There was only the three keys to the room and no one got in there that I know of.

MR. SCOTT: That is all.

WITNESS EXCUSED.

MR. SCOTT: Our case will be closed with the exception of some reports of assays of demonstrations which I submitted to Mr. Williams this morning and in regard to which I have not heard from him as to his wishes.

MR. WILLIAMS: If you will strike that out, and strike that out, I will admit it.

MR. GARRISON: The defendant desires me to stipulate and I do so, that the sample of the kerosene oil used by Dr. Phillips was furnished to Mr. Chapman, as the witness says it was.

MR. SCOTT: I offer in evidence report of operations of the miniature flotation plant that was exhibited

to the court in the grand jury room. The parts that I have marked off are taken off by stipulation.

The report was admitted in evidence marked DEFENDANT'S EXHIBIT 302.

MR. SCOTT: And I offer in evidence a report giving a screen analysis of the material treated at the Butte & Superior mill on April 29th, 1917, being upon the occasion of the inspection of the mill by the representatives of the Minerals Separation, Limited.

Said report of screen analysis was admitted in evidence marked DEFENDANT'S EXHIBIT No. 303.

MR. SCOTT: I offer in evidence report of the assay results of several tests performed by Mr. B. H. Dosenbach, the tests being designated, Everson test No. 30, Everson test 31, Kirby test No. 32, Butte & Superior alternate Cattermole and patent in suit, Test No. 33; Butte & Superior test No. 36.

Said report of assay results admitted in evidence marked DEFENDANT'S EXHIBIT No. 304.

MR. SCOTT: I offer in evidence a report entitled the result of the experiments performed in court as testified to by B. H. Dosenbach, test No. 34. This is a test in the Janney flotation machine.

Said report admitted in evidence marked DEFENDANT'S EXHIBIT No. 305.

MR. SCOTT: I offer in evidence three photographs of the miniature flotation machine which was exhibited in the grand jury room.

Said photographs were admitted in evidence, and marked DEFENDANT'S EXHIBITS 306, 307 and 308 respectively.

MR. SCOTT: I would like the record to show that this bottle of oil is offered for inspection of the plaintiff, and will be offered in evidence if they so desire.

MR. GARRISON: I can see no relevancy in that offer. It is admitted that whatever Dr. Phillips used was furnished to us. The utmost that their witness has said was that it came out of this bottle. I see no reason why we should be burdened with the bottle as an exhibit.

THE COURT: There is nothing for the court to say.

MR. GARRISON: Well, I object.

MR. SCOTT: I offered it conditional on your requesting it.

MR. GARRISON: Well, I will relieve the court by stating that I don't request it.

THE COURT: Very well. Does that conclude the defendant's case?

MR. SCOTT: Defendant's case is concluded.

MR. KENYON: Before defendant's case is concluded I wish to offer an exhibit which is connected with defendant's case. Counsel asked plaintiff's ex-

pert witness, Mr. Wiggin, to produce certain tabulations and figures and I now produce them in his behalf, and he is in court to explain them if desired; namely: a copy from the daily records of the reagent consumption in the copper sand, copper slime, and zinc ore concentrators, for the months of January, February and March, 1917, in the Washoe plant; also copy from the same source of the daily records of the copper contents in the current mill slime, that being the only record the witness could get. Also three tables giving the aggregate or average reagent consumption and sulphide contents of the ore in the three concentrators for the months of January, February and March, 1917.

These are offered in evidence with consecutive exhibit numbers.

Tables admitted in evidence and marked PLAINTIFF'S EXHIBITS 309, 310, 311, 312, 313, 314 and 315.

MR. SCOTT: There is one thing I forgot; I calculated to recall Mr. Wicks to show how a discrepancy arose on his figures. I would like to recall him now.

THE COURT: Very well.

Frank R. Wicks.

FRANK R. WICKS, recalled in behalf of the defendant in sur-rebuttal, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 1. Mr. Wicks, have you examined plaintiff's exhibit 255, being a compilation of figures relating to the Chino Company?

A. Yes, sir.

Q. 2. Have you compared it with the report you produced, from which the figures are drawn?

A. Yes.

Q. 3. Now, I don't think you need put any further compilation of the matter in; if you will simply explain the relation of plaintiff's exhibit 255 to your compilation from which the figures were drawn, explaining their failure to check up, that will be all that is necessary.

A. All right. Now, referring to plaintiff's exhibit 255, particularly the last line, which is the data pertaining to the 18th, 19th and 20th of November, the average assay of the tailings as given on that line is .244, which is taken from exhibit 29. The calaculation shown on the column just preceding that, calculated tailings .489 I endeavored to check that, and in doing so I check back on each of the individual days on which those were made up, and following out the method followed by Mr. Wilding which I have designated as the M. S. method, I found that on the 18th

Frank R. Wicks.

the caluculated tailing would be .27 as compared with a tailing shown by the assay of .26. That .26 tailing may be found on the copy of the monthly statement that I presented as defendant's exhibit 230, which contains the detail from which exhibit 29 was made up. The calculated tailing, following the same method, for the 19th of November, would be .265, as compared with .29, contained in the regular sheet; and for the 20th it will be .14 calculated tailing, against .17 assay; so that the check all through there for those three days is remarkably close.

Then in checking back to endeavor to locate the discrepancy I found that the average concentrate assay as shown on exhibit 29 for November 18th, 19th and 20th, which is 29.28 per cent copper on exhibit 29—that a recalculation of that figure from the individual assays shown on exhibit 230 shows that that 29.28 should have been 29.78, evidently a typographical error. It appears very small, but yet it completely alters the calculation of the tailings shown by Mr. Wilding on his exhibit 255, and I do not see how he could have failed to find that if he had gone through these figures because he had my exhibit 230 before him several days before this was presented. But, any way, a recalculation of that tailing based on the correct concentrate assay shows that, following the M. S. method, that calculated tailing should be .233, as compared with an assay given in the following column of .244, which is remarkably close. Now, of course, changing that concentrate assay there from

Frank R. Wicks.

29.28 to 29.78 changes the recovery a little, but the change is only from 98.437 to 98.423, which is practically nothing. The change in the calculated assay, which Mr. Wilding has shown as 96.84, then becomes 98.49, which has to be compared with 98.42. Now, that takes care of that.

Now, in the case of this whole statement I should say that it shows that the concentrate shown under the heading of flotation concentrate ton on exhibit 255 prepared by Mr. Wilding, are not actual weights, and to verify that I would refer back to my testimony covering that matter, which is page 371 of the transcript, question 599. This refers to the methods of comparison between the actual dry weights and the theoretical amounts of concentrate produced by the various plants. I would also refer to page 346, question 474. I think that is the right number, but the book I took that from was not numbered and I am not exactly sure that that was the question. But on page 346, anyway, where I show that the concentrates were all mixed in the settling system before they were weighed, so it is necessary to take the theoretical amounts from the various plants as the actual figures, because there is no way of obtaining actual dry weights by the—of the individual flotation plants. Anyway, they are close enough for an average for the calculations that we have to make at the plant.

Now, there is just one other thing. Mr. Wilding by exhibit 255 made some calculations based on the cost of smelting the concentrate and the cost of con-

centration and so on, and he based that on the cost per ton. Now, the cost per ton for ordinary mill work is close enough for approximations of some things all the way, where the material considered is approximately of the same character throughout. But the cost per ton on comparisons of material that are quite unlike leads to erroneous conclusions. Wherever accurate work is necessary we always base our figures on the cost per pound of copper, because the copper is what we have to sell, and the cost per pound and what we get for it is really the most important thing about the plant. Recalculating the figures shown on exhibit 255 and basing it on the pounds of copper contained in the material treated, which after all is the most important thing, I have prepared another exhibit showing the pounds of copper in the tailing per pound of copper in the heads. I should refer to the loss of copper in the tailings per pound of copper in the head, about the middle of the exhibit. There is the calculation of the number of pounds of copper actually lost in the tailings per pound of copper in the heading, which is the unit that it is most important to figure on. And then in the column following that it is the value of that at twenty cents per pound, the price which Mr. Wilding assumed. Then I left the smelting charge as Mr. Wilding assumed it, at $6.00 per ton, and the total as he left it, and then I figured that in the cost of smelting per pound of copper in the headings. Then I calculated the cost of the oil and the cost of the reagent and added that to the

Frank R. Wicks.

value of the copper, and in the third column at the end I showed the total cost of oil, reagents and the value of the copper lost in the tailing, and all figured back per pound of copper in the feed, and I found that instead of the tremendous difference shown by Mr. Wilding in the column corresponding, that the figures are very nearly the same cost throughout, but what little difference there is is really in favor of the days on which we used the large quantities of oil. I think that completes the explanation.

Q. 4. You said, Mr. Wicks, that the weights were derived from the daily calculations by the foreman, did you not?

A. Yes.

Q. 5. Will you state how the assay figures are derived?

A. Well, the assays are actual assays of the samples taken for the day or rather for each of the three shifts for the day.

Q. 6. What I was trying to get at is is your assay applied to the concentrates made during the particular period that the assay covered?

A. Yes, sir.

Q. 7. That is, if you have an assay that you might call a composite assay, is that applied to the product of January 1st?

A. That is applied to the product of January 1st, yes.

Q. 8. For what purpose, for the purpose of finding the amount of the concentrate?

Frank R. Wicks.

A. For determining the actual quality of the work that we are doing and from those assays to get the tonnage of the concentrate which is calculated in this case.

Q. 9. Referring to this tabulation which you have been looking at how do you get that figure "assay per cent copper," which is in the second column for the third quarter of 1916?

A. In the case of the third quarter of 1916 that is a calculated average for the 92 days of the quarter.

Q. 10. Just one composite assay applied to the whole period?

A. No, that is a calculation of the daily assays and they are averaged up geometrically.

Q. 11. And how about the tonnage, 6804 for the same period, the third quarter of 1916?

A. Well, that 6084 tons represents the arithmetical addition of the calculated quantities for each day. We have always recognized that that was not absolutely accurate, because of the calculation. For instance, if we take the average assays for the month and the calculated tonnage of concentrate from that, it does not always agree exactly with the arithmetical additions of the individual days, but saving confusion in our figures we always take the arithmetical addition of the individual days. This discrepancy is sometimes one way and sometimes the other, but it is not important in our work.

MR. SCOTT: I would like to offer this tabulation that the witness produced, entitled "Minerals

Frank R. Wicks.

Separation, Limited, vs. Butte & Superior Mining Company, referring to defendant's exhibit No. 29, Chino Copper Company, retreatment of vanner concentrates."

Said tabulation was admitted marked DEFENDANT'S EXHIBIT 316.

CROSS EXAMINATION,

BY MR. KENYON:

X-Q. 12. Referring to plaintiff's exhibit 255, is Mr. Wilding's figure correct in the third column of that exhibit for "Contents, Pounds of Copper in the Headings"?

A. Yes, sir, I find that correct.

X-Q. 13. You have made a correction in the sixth column headed, "Assay of Copper Flotation Concentrates," changing that figure in the last column from 29.28 to 29.78, as I understand you?

A. Yes, sir.

X-Q. 14. What change will that make in the next succeeding figure in that line, namely, "Contents, Pounds of Copper, Flotation Concentrates"?

A. That changes the pounds of copper in the concentrate from 111,264, shown by Mr. Wilding, to 113,164.

X-Q. 15. How will that change the figure under the heading "Tailings, contents pounds of copper, by difference"?

A. Mr. Wilding shows 3629, and I get 1729.

X-Q. 16. By subtracting what from what?

A. By subtracting the figure shown in the third column from that shown in the seventh column.

X-Q. 17. And referring to the column "Loss of Copper in Tailings per ton of the Headings, Pound" and the last figure in that column what change will that require in that figure which is 6.47?

A. Well, I figured that back instead of in loss of copper per ton of heading, I figured it back in loss of copper per pound of copper in the heading.

X-Q. 18. Well, I asked you what change that would make in the figure 6.47, which indicates the loss of copper in tailings per ton in ton of heading?

A. That can be easily calculated.

X-Q. 19. Please do so.

A. That would be 3.08 instead of 6.47.

X-Q. 20. What change will be required in the next column, being the column "If One Pound of Copper in Concentrate be Worth 20 Cents Net to the Mill"?

A. You are referring to exhibit 255?

X-Q. 21. Yes.

A. That would be approximately .616.

X-Q. 22. What change, if any will be involved in the second column after that heading "Cost of Smelting Concentrate, Total"?

A. I left those figures just as Mr. Wilding showed them.

X-Q. 23. They are correct are they?

Frank R. Wicks.

A. I am not certain as to just what the smelting charge is, but Mr. Wilding assumed $6.00 per ton and I left it that way.

X-Q. 24. That is a fair amount?

A. I believe it is approximately right, but I am not sure as to the exact figure.

X-Q. 25. That is for hauling and treatment, is it?

A. That is what it is headed in this exhibit.

X-Q. 26. That is what you mean when you say it is a fair figure?

A. Yes, I believe it is approximately right.

X-Q. 27. Then what change will be required in the next two columns here, "Cost of Concentration per Ton of Heading"?

A. There will be no change in that per ton of headings in Mr. Wilding's statement.

X-Q. 28. But the second of those two columns?

A. To what are you referring now, "Cost of Concentrate"?

X-Q. 29. "Cost of Concentration" and the second column headed "Cost per ton of heading, including loss in tails and cost of smelting"?

A. Well, in those figures there, I simply excluded those figures from my calculation and recalculated on my basis of cost per ton of copper in headings because I believe that is more accurate.

X-Q. 30. Well, in this again, the only change required would be that the figure $1.294 should be changed to $.616, isn't it?

Frank R. Wicks.

A. No. I went back and took the actual cost of oil from our statement, and applied that under the heading of cost of oil per pound copper in the headings, in exhibit 316. I failed to find that difference of 15 cents per ton increase in the cost of oil. There is an actual increase all right, but it don't figure quite that amount.

X-Q. 31. That figure 15, as explained by Mr. Wilding is not only the cost of oil, but the additional cost occasioned by the use of that additional oil. Is not that about a fair estimate per ton of heading?

A. Well, there is no additional cost due to the large quantity of oil other than the oil itself.

X-Q. 32. Isn't that a pretty fair estimate per ton of heading?

A. Well, I figure it to be about 6 cents as near as I can figure from these statements.

X-Q. 33. Won't you please consider that pretty carefully, as the discrepancy seems to be, to me, considerable? An estimate of 15 cents is given as a conservative estimate by Mr. Wilding.

A. Upon what did he base his figures? I can give you the total cost if you wish, and then we can figure it from that. The total cost of the oil for the three days, November 18th, 19th and 20th, was $506.21, which is 90 cents a ton. The total cost of oil, for October was $2615.00. Yes, that is 28 cents a ton. There is more difference there than I thought.

X-Q. 34. What is the additional cost of oil per ton of heading?

Frank R. Wicks.

A. In this case it would be the difference between 28 and 90 cents, 62 cents.

X-Q. 35. And the 62 cents per ton of headings is correct, instead of 15 cents per ton of heading?

A. Yes, in calculating I pointed out wrong.

X-Q. 36. Are you quite sure you are correct now?

A. I believe that is right.

X-Q. 37. THE COURT: Let me understand this exhibit 316. Total cost of oil per pound of copper in the heading, does it mean that on these three days your oil cost you nearly four and a half cents on the copper?

A. Nearly four and a half cents on the copper.

X-Q. 38. THE COURT: For every pound of copper?

A. For every pound of copper; unless these figures are wrong, and I believe they are right. That is typewritten wrong; that should be .00446. Mr. Scott, have you my original figures on that that I handed you with this exhibit? Well, then, that figure under "Cost of concentration, cost per pound of copper in the heading," the last line should be .00446.

X-Q. 39. Instead of .0446?

A. Yes. It does not affect the total shown in that second column from there.

X-Q. 40. Now, Mr. Wicks returning to plaintiff's exhibit 255 and to the double column headed "Cost of Concentration" in the last line, as I understand you, the figure 15 should be 62 in the first column, "A," plus 62, for the extra oil?

Frank R. Wicks.

A. I shall have to recalculate that now; yes, that is approximately right.

X-Q. 41. Now, in the second, the broad column there, the last entry should be A, plus 0.62, should it?

A. Well, that is a entirely erroneous column. It is absolutely unjust to figure on that basis at all.

X-Q. 42. Please answer the question.

A. I haven't calculated it.

X-Q. 43. That figure, which is intended to be a repetition of what is shown in the preceding column, you have corrected that to A plus 62, and the repetition should equally be A plus 62, should it not?

A. I have no doubt but what that is a proper figure.

X-Q. 44. Now, take the next figure, the next figure is 1.294 and was taken from the fifth preceding column. 1.294 which you have corrected to .616 now will make the correction of this column .616, the last figure, plus 2.032, was taken from the second preceding column which you have said was substantially correct. The addition there should be equally A plus —how much, as so corrected?

A. That would be A plus 3.268 instead of A plus 3.476.

X-Q. 45. I observe from the second column of that, of this exhibit 255, that the grade of the headings on that three days, November 18th, 19th and 20th, 1916, was distinctly higher than during the other two periods?

A. Yes, sir.

Frank R. Wicks.

X-Q. 46. Then that is to say there were more pounds of copper in each ton of heading that went to the mill?

A. Yes, sir—not that went to the mill—that went to this plant.

X-Q. 47. That went to the flotation plant. Therefore, when you divide the total cost of treating that tonnage by that large number of pounds in about the ratio of ten to seven you would get an apparent cost that was less, although the actual cost of treating the same tonnage would be more; is that correct?

A. Yes, sir; that is a little confused. May I ask you to state it another way?

X-Q. 48. You ask me to state it another way?

A. I don't understand it as you stated it.

X-Q. 49. Is the cost determined by the number of pounds of copper in the headings or by the number of tons of ore in the headings that you have to treat?

A. The cost is largely determined—largely dependent upon the number of pounds of copper in the headings, yes sir.

X-Q. 50. THE COURT: What does your oil cost ordinarily?

A. The two oils that we used there at that time cost us 32 cents a gallon for one and 5½ cents a gallon for the other.

X-Q. 51. THE COURT: Is it a mixture?

A. This is a mixture; yes, sir, and I gave Mr. Williams the exact number of pounds of oil that we used

Frank R. Wicks.

on each of the days under discussion. I have the record here so that we can repeat it if you wish.

THE COURT: Not if they have it.

X-Q. 52. MR. KENYON: I can understand, Mr. Wicks, that for the purpose of determining profits it might be proper to divide the full cost by the number of pounds of copper in the heading, but for the purpose of comparing a metallurgical operation, the cost of treating your ore at different periods where the grade of the heading is varied, isn't it a fairer operation to consider it from the point of view of the tonnage of the headings?

A. No, I don't think so, Mr. Kenyon, because the material that contains the headings percentage of copper always costs us more money to treat.

X-Q. 53. Per ton of head, or per ton of copper?

A. No, per ton of headings in the copper, costs us more when there is more copper in the headings; in other words the cost varies more nearly directly as the assay of the heads, or the pounds of copper in the heads, than it does on the basis of the tonnage.

X-Q. 54. And is this an instance where the higher grade of the headings made the treatment cost you more?

A. Yes, the higher grade of the headings here required more oil, which of course added to the cost.

X-Q. 55. In the ratio of seven to ten?

A. Approximately, although not exactly, for perhaps the oil mixtures were not quite alike.

Frank R. Wicks.

X-Q. 56. In view of this difference that you have spoken of in the cost of treating the headings, that are higher in grade, as compared with the headings that are lower in grade, do you regard it as a proper comparison when you are comparing a metallurgical operation with another metallurgical operation to select periods where the headings were so distinctly and radically different as in this case?

A. Where the headings are radically different, it is the only method that I know that is accurate.

X-Q. 57. In these operations on these three days for every ton of heading that went into the flotation, 3.8 pounds of copper were lost as compared with 2.62, and 2.10 in the two earlier periods. That is correct, is it?

A. Yes, sir, that is correct.

WITNESS EXCUSED.

MR. SCOTT: I think our case is closed, now, your honor.

MR. WILLIAMS: I wish to offer in evidence table of the assays of the plaintiff as to the product obtained in the operation of the Butte & Superior miniature plant.

Said table of assays was admitted in evidence and marked PLAINTIFF'S EXHIBIT 317.

MR. WILLIAMS: I also offer in evidence a table

of assays as to the tests made in the course of the experiments made in court by Mr. Higgins.

Said table of assays was admitted marked

PLAINTIFF'S EXHIBIT 318.

MR. WILLIAMS: The usual stipulation applying to all these assays, that they are to be received in evidence with the same force and effect as if the witness who made the assays appeared and testified. Now, I have some photographs of pages of Ure's dictionary to offer in evidence and we will not be able to do that until tomorrow, but that is purely a matter of form.

THE COURT: This exhibit 316, do we understand Mr. Wicks to say that these oil mixtures were all the same those three days?

MR. SCOTT: I will have to ask, your honor.

MR. WICKS recalled, testified as follows:

DIRECT EXAMINATION,

BY MR. SCOTT:

Q. 58. THE COURT: I was asking if you had testified your oil mixtures were the same on this exhibit 316.

A. I gave Mr. Williams the oil mixture that was used on these individual days. I don't think that I gave him the exact oil mixtures that were used during the third quarter and during October.

Q. 59. Well, were they the same?

Frank R. Wicks.

A. They were the same oils, but the proportions of the different oils varied from time to time.

MR. KENYON: Can you give that to us now?

A. Yes, sir.

Q. 60. Please give that to us now, from the record.

MR. WICKES, Recalled, testified as follows:

DIRECT EXAMINATION

BY MR. SCOTT:

Q. 61. What months are you giving for us now?

A. I have July and August and September, constituting the third quarter of 1916. Now, I haven't these figures totalled up; I have them for each individual day.

Q. 62. Well, read off some representative days?

A. How do you wish me to give them to you?

Q. 63. Well, start on the first of the month.

A. On the first of July we were using Lewis creosote and Jones—

Q. 64. MR. KENYON: Can't you tabulate that for us in some convenient way and then put it in afterwards?

THE COURT: All that the court wanted to know is—you were using a much cheaper mixture for those three days as I understand it?

THE WITNESS: Yes, sir. The Jones oil costs only five and a half cents a gallon, and the Barrett's No. 4 oil costs 32 cents a gallon, and then the propor-

tion of those two oils is changed from time to time back and forth, according to the conditions required in the plant. I notice back in July that we were using what is called the Lewis' creosote, but it is practically the same as the Barrett creosote; it comes from a different place, but it serves the same purpose.

THE COURT: I had only noted from his figures that it must be much cheaper, and I wanted to be sure.

MR. SCOTT: He can make a tabulation and present it afterwards.

THE COURT: Does that close the case, and are you ready for the argument?

MR. GARRISON: If your honor please, on behalf of both sides I desire to submit to your honor for your approval, if you do approve of it, the method in which counsel would like to dispose of this case. With your honor's permission we would like to adjourn now until tomorrow morning, so as to enable each side to have the intervening time to prepare their arguments, and we would then like, instead of having the 15 hours which we had previously agreed upon, being three court days of five hours each to dispose of the case in two days of six hours each, sitting from 10 to one and from two to five, and dividing those 12 hours equally between us. Does that meet with your honor's approval?

THE COURT: If both sides are agreed, it is satisfactory to the court.

MR. GARRISON: I desire to give notice to court

and counsel on the other side—at the time that we pressed the question of the effect of the Hyde decision upon this case, we had hoped that it could be segregated and decided without the necessity of going into the merits of the case. Our hope was—I am rather inclined to think it was never more than a pious hope—that we could get your honor to decide that point in the case separately, so that, if it was in our favor, we need not go into the other evidence, which would be otherwise necessary. Your honor, with entire propriety, it being entirely a matter of discretion, determined that it would be the proper way to have the entire case tried upon the merits, and your honor has reserved for final consideration the question of res adjudicata. We determined, under those circumstances, to abandon the point of res adjudicata, and have this case entirely decided upon the merits. I therefore now give notice to the other side that we abandon the charge of res adjudicata.

MR. KREMER: Thank you, Judge. That relieves me. I think the arguments may be considerably shortened.

THE COURT: Let the record show the statement of counsel.

MR. GARRISON: Yes, sir, it was made for that purpose.

THE COURT: You spoke once about desiring that the court should go out and look at these plants?

MR. SCOTT: Would it be agreeable to the court

to go? It would be agreeable to me to have the court go this afternoon.

THE COURT: Do you still desire it? Do you think it will aid us in arriving at a conclusion in this case? If you do, the court is willing to go.

MR. SCOTT: That is my state of mind, your honor. I really feel that we have talked so much about these matters and have shown little miniature plants to the court, that if the court has actually seen the operations I think it will be helpful.

MR. GARRISON: I would like to have your honor see the Timber Butte plant too. That is within easy automobiling distance. We will, of course, furnish cars. I suppose both sides ought to join in that so there will be no question about it.

MR. SCOTT: Certainly.

MR. GARRISON: It will not require but a very limited time to take them both in; it can be readily done in the course of the afternoon, before dinner time.

THE COURT: Very well. The court is willing to go.

WHEREUPON an adjournment was taken until Wednesday, May 16th, 1917, at 10:00 a. m.